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Akademiya Nauk SSSR, Bulletin [Izvestiya], Geologic Series, in English translation (American Geological Institute). Washington, D. C.
American Journal of Science. New Haven, Connecticut.
American Mineralogist (Mineralogical Society of America). Ann Arbor, Michigan.
American Museum of Natural History, American Museum Novitates. New York.
Boston Society of Civil Engineers, Journal.
Brigham Young University, Dept. of Geology, Brigham Young University Research Studies, Geology Series Provo, Utah.
Bulletins of American Paleontology (Paleontological Research Institution). Ithaca, New York.
California, Dept. of Water Resources, Bulletin. [Sacramento?].
Canada, Dept. of Mines and Technical Surveys, Geographical Branch, Bibliographical Series; Memoir, Ottawa.
Canada, Geological Survey, Geophysics Paper; Map. Ottawa.
Canadian Mining Journal. Gardenvale, Quebec.
Carleton University, Dept. of Geology, Geological Paper. Ottawa.
Civil Engineering. Easton, Pennsylvania.
Colorado School of Mines, Mineral Industries Bulletin. Golden.
Copeia. Ann Arbor, Michigan.
Cushman Foundation for Foraminiferal Research, Contribution. Ithaca, New York.
Earth Science. Chicago.
Ecology (Ecological Society of America). Durham, North Carolina.
Explosives Engineer. Wilmington, Delaware.
Florida Geological Survey, Contributions to Florida Vertebrate Paleontology, Paper: Report of Investigations; Special Publication. Tallahassee.
Geographical Review (American Geographical Society). New York.
Geokhimiya. Geochemistry; a translation of the journal of the Academy of Sciences, U. S. S. R., devoted to geochemistry (Geochemical Society). Ann Arbor, Michigan.
Geological Society of America, Bulletin; Memoir. New York.
Journal of Geophysical Research. Washington, D. C.
Kansas, State Geological Survey, Miscellaneous Report. Lawrence.
Kentucky Geological Survey, Special Publication. Lexington.
Limnology and Oceanography (American Society of Limnology and Oceanography). Lawrence.
Los Angeles County Museum, Contributions in Science. Los Angeles.
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Mines Magazine (Colorado School of Mines, Alumni Association). Denver.
Mining Engineering (American Institute of Mining, Metallurgical and Petroleum Engineers). New York.
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Oklahoma Geological Survey, Bulletin; Circular. Norman.
Oklahoma Geology Notes (Oklahoma Geological Survey). Norman.
Pennsylvania Geological Survey, Bulletin. Harrisburg.
Pennsylvania State University, Mineral Industries Experiment Station, Bulletin. University Park.
Quebec (Province), Dept. of Mines, Geological Report. Quebec.
Royal Society of Canada, Transactions, Section 5, Biological Sciences. Ottawa.
Science. Washington, D. C.
South Dakota Academy of Science, Proceedings. Vermillion.
Southern California Academy of Sciences, Bulletin. Los Angeles.
U. S. Air Force, Cambridge Research Center, Geophysics Research Directorate, Geophysical Research Paper. Cambridge, Massachusetts.
U. S. Geological Survey, Circular; Ground Water Notes; Professional Paper; Reports, Open-File Series; Water-Supply Paper. Washington, D. C.
Utah Academy of Sciences, Arts, and Letters, Proceedings. [Logan?].
Virginia, Division of Mineral Resources, Bulletin; Mineral Resources Report. Charlottesville.
World Oil. Houston, Texas.

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Those wishing to purchase items abstracted herein should address their orders to the agency, society, or organization indicated in the bibliographic citations preceding the abstracts, or to their local book dealer. The city and state for the serials cited are given above. The American Geological Institute, publisher of GeoScience Abstracts, regrets that it cannot fill purchase orders for abstracted publications other than its own.

GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Structural Geology 2-1396.

2-1309. Mountjoy, Eric Walter. GEOLOGY, MIETTE, WEST OF FIFTH MERIDIAN, ALBERTA: Canada, Geol. Survey, Map 40-1959, Scale 1:63,360, marginal notes, 1960, 2 refs.

Preliminary series geological map of some 260 sq. mi. in the foothills and front ranges of the central Alberta Rocky Mountains, just E. of Jasper. Several W.-dipping thrust sheets, some of which are folded and faulted, occur, and the whole area has a strongly developed northwesterly trend of parallel structural pattern that is reflected in the exposure of the rock units. Cambrian, Ordovician, Devonian, Mississippian, Permian and possibly Pennsylvanian, Triassic, Jurassic, and Cretaceous marine rocks are exposed. Coal seams occur in the Lower Cretaceous Luscar formation, and structures suitable for the accumulation of gas and oil may be present at depth.--P. Harker.

2-1310. Fyles, John G. SURFICIAL GEOLOGY, OYSTER RIVER, COMOX, NANAIMO AND SAYWARD DISTRICTS, BRITISH COLUMBIA: Canada, Geol. Survey, Map 49-1959, scale 1:63,360, 1960.

Preliminary series map covering about 380 sq. mi. near the midlength of the NE. shore of Vancouver Island. Deposits of the last regional glaciation (Vashon drift) are underlain by the Quadra sediments of fluvial origin that record a major interstadial interval. There are also some other extensive deposits beneath the Vashon ground moraine whose relationship to Quadra sediments is not known. Marine and fluvial deposits overlying the Vashon drift are designated as the Capilano sediments and the Salish sediments. The Capilano sediments accumulated during an early postglacial interval when sea level was higher than at present; the Salish deposits were deposited under modern conditions and are still being formed.--P. Harker.

2-1311. Anderson, Francis D., and W.H. Poole. GEOLOGY, WOODSTOCK-FREDERICTON, YORK, CARLETON, SUNBURY AND NORTHUMBERLAND COUNTIES, NEW BRUNSWICK: Canada, Geol. Survey, Map 37-1959, scale 1:126,720, marginal notes, 1959, 13 refs.

Preliminary series geological map covering about 1,000 sq. mi. of southwestern New Brunswick, N. and W. of Fredericton. The area embraces the southwestern end of a belt of granitic batholiths and deformed early Paleozoic rocks that extends northeasterly from Maine to Bathurst. Intensely deformed sedimentary and volcanic strata of Ordovician, Silurian, and Devonian age have been intruded by granitic batholiths and overlain unconformably by undeformed coarse clastic sediments and few volcanic rocks of Carboniferous age. A central southwesterly trending belt of Ordovician rocks is flanked by Silurian strata on the SE. and Silurian and Devonian strata on the NW. The nature of the Ordovician-Silurian contact is uncertain. Ferruginous and manganiferous strata occur in both Ordovician and Silurian systems. Those of Silurian age near Woodstock are being investigated with a view to producing ferro-manganese. Base metal deposits occur sporadically in Ordovician strata. Stibnite has been mined from quartz veins cutting Silurian strata. Radioactive minerals were recently found in Carboniferous rhyolitic rocks. Coal prospects occur in Pennsylvanian sediments.--W. H. Poole.

2-1312. MacLaren, A.S. AEROMAGNETIC MAP, WHOLDAIA LAKE EAST, DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 1080A, scale 1:253,440, marginal notes, 1959, 4 refs

Aeromagnetic map covering the area 60°-61°N., 102°-104°W. This is a composite map compiled from 16 aeromagnetic maps previously published by the Geological Survey of Canada on a scale of 1 in. to 1 mi. Flight line traces are eliminated, and base map detail is generalized and reduced to a minimum. Flights were made at an altitude of 1,000 ft. above ground level.--P. Harker.

2-1313. Hughes, Owen L. SURFICIAL GEOLOGY, IROQUOIS FALLS, COCHRANE DISTRICT, ONTARIO: Canada, Geol. Survey, Map 46-1959, scale 1:126,720, marginal notes, 1960.

Preliminary series map covering about 800 sq. mi. The area lies due N. of Toronto and just W. of Timmins. Wisconsin ice covered the area and deposited glacial till containing lenses of gravel. Concurrent with northward retreat of the ice margin, the area was occupied by glacial lake Barlow-Ojibway. The lake extended from the S. end of Lake Timiskaming northward across the continental divide which was then depressed below the level of the outlet through Timiskaming gorge. Subglacial streams, entering into the lake at the ice margin, deposited sand and gravel, forming elongate esker complexes. Silt and clay carried by the subglacial streams were deposited on the lake bottom as annual layers or varves. Northward retreat of the ice margin caused shallowing of the glacial lake, and bedrock knobs appeared as islands and were swept free of drift by wave erosion. Subsequent southward expansion of a lobe of ice deposited the Cochrane till. Thin deposits of lacustrine sediments were deposited in a shallow glacial lake or lakes which persisted along the margin of the lobe as it retreated after a brief stand.--P. Harker.

2-1314. Canada, Geological Survey and Ontario, Dept. of Mines. ANENIMUS RIVER, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 890, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 50°30'-50°45'N., long. 91°30'-92°W., 1960.

2-1315. Canada, Geological Survey and Ontario, Dept. of Mines. OTATAKAN LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 891, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 50°45'-51°N., long 91°30'-92°W., 1960.

2-1316. Canada, Geological Survey and Ontario, Dept. of Mines. WESLEYAN LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 892, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°-51°15'N., long. 91°30'-92°W., 1960.

2-1317. Canada, Geological Survey and Ontario, Dept. of Mines. ZIONZ LAKE, KENORA DISTRICT,

ONTARIO: Canada, Geol. Survey, Geophysics Paper 893, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°15'-51°30'N., long. 91°30'-92°W., 1960.

2-1318. Canada, Geological Survey and Ontario, Dept. of Mines. CAT LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 894, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°30'-51°45'N., long. 91°30'-92°W., 1960.

2-1319. Canada, Geological Survey and Ontario, Dept. of Mines. WHITESTONE LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 895, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°45'-52°N., long. 91°30'-92°W., 1960.

2-1320. Canada, Geological Survey and Ontario, Dept. of Mines. McCAULEY LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 896, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°-52°15'N., long. 91°30'-92°W., 1960.

2-1321. Canada, Geological Survey and Ontario, Dept. of Mines. SHINBONE LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 897, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°15'-52°30'N., long. 91°30'-92°W., 1960.

2-1322. Canada, Geological Survey and Ontario, Dept. of Mines. WINDIGO LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 898, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°30'-52°45'N., long. 91°30'-92°W., 1960.

2-1323. Canada, Geological Survey and Ontario, Dept. of Mines. NIKIP LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 899, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°45'-53°N., 91°30'-92°W., 1960.

2-1324. Canada, Geological Survey and Ontario, Dept. of Mines. ST. RAPHAEL LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 900, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 50°30'-50°45'N., long 91°-91°30'W., 1960.

2-1325. Canada, Geological Survey and Ontario, Dept. of Mines. LINDBERGH LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 901, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 50°45'-51°N., long. 91°-91°30'W., 1960.

2-1326. Canada, Geological Survey and Ontario, Dept. of Mines. BLACKSTONE LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 902, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°-51°15'N., long. 91°-91°30'W., 1960.

2-1327. Canada, Geological Survey and Ontario, Dept. of Mines. OBASKAKA LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 903, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°15'-51°30'N., long. 91°-91°30'W., 1960.

2-1328. Canada, Geological Survey and Ontario, Dept. of Mines. GITCHE RIVER, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 904, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°30'-51°45'N., long. 91°-91°30'W., 1960.

2-1329. Canada, Geological Survey and Ontario, Dept. of Mines. UPTURNEDROOT LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 905, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°45'-52°N., 91°-91°30'W., 1960.

2-1330. Canada, Geological Survey and Ontario, Dept. of Mines. HINTON LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 906, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°-52°15'N., long. 91°-91°30'W., 1960.

2-1331. Canada, Geological Survey and Ontario, Dept. of Mines. STIRLAND LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 907, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°15'-52°30'N., long. 91°-91°30'W., 1960.

2-1332. Canada, Geological Survey and Ontario, Dept. of Mines. YOYOY LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 908, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°30'-52°45'N., long. 91°-91°30'W., 1960.

2-1333. Canada, Geological Survey and Ontario, Dept. of Mines. WEAGAMOW LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 909, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°45'-53°N., long. 91°-91°30'W., 1960.

2-1334. Canada, Geological Survey and Ontario, Dept. of Mines. DE LESSEPS LAKE, THUNDER BAY AND KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 910, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 50°30'-50°45'N., long. 90°30'-91°W., 1960.

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2-1336. Canada, Geological Survey and Ontario, Dept. of Mines. LAKE ST. JOSEPH WEST, KENORA AND THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 912, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°-51°15'N., long. 90°30'-91°W., 1960.

2-1337. Canada, Geological Survey and Ontario, Dept. of Mines. KAWINOGANS LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 913, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°15'-51°30'N., long. 90°30'-91°W., 1960.

2-1338. Canada, Geological Survey and Ontario, Dept. of Mines. DOBIE RIVER, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 914, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°30'-51°45'N., long. 90°30'-91°W., 1960.

2-1339. Canada, Geological Survey and Ontario, Dept. of Mines. OBABIKA LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 915, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°45'-52°N., long. 90°30'-91°W., 1960.

2-1340. Canada, Geological Survey and Ontario, Dept. of Mines. KECHEOKAGAN LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 916, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°-52°15'N., long. 90°30'-91°W., 1960.

2-1341. Canada, Geological Survey and Ontario, Dept. of Mines. MAWLEY LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 917, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°15'-52°30'N., long. 90°30'-91°W., 1960.

2-1342. Canada, Geological Survey and Ontario, Dept. of Mines. DONNELLY RIVER, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 918, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°30'-52°45'N., long. 90°30'-91°W., 1960.

2-1343. Canada, Geological Survey and Ontario, Dept. of Mines. NORTH CARIBOU LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 919, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°45'-53°N., long. 90°30'-91°W., 1960.

2-1344. Karrow, P.F. SURFICIAL GEOLOGY, BERTHIER-GRONDINES, CHAMPLAIN, PORTNEUF, LOTBINIÈRE, AND NICOLET COUNTIES, QUEBEC: Canada Geol. Survey, Map 41-1959, scale 1:63,360, marginal notes, 1959.

Preliminary series map covering about 380 sq. mi. on the N. shore of the St. Lawrence River. Earliest Pleistocene sediments are varved clays in a proglacial lake. Ice of possible Illinoian age overrode the varved clays, depositing Becancour till. Following a nonglacial interval, Wisconsin ice disrupted drainage and formed a second proglacial lake, lake Deschaillons. After deposition of the Gentilly till, the ice retreated, allowing marine waters of the Champlain sea to flood the depressed lowland.--P. Harker.

2-1345. Jewett, John M., GRAPHIC COLUMN AND CLASSIFICATION OF ROCKS IN KANSAS: Kansas, State Geol. Survey, chart (columnar sec.), scale (vert.) approx. 1 in. to 75 ft., 1959, pub. 1960.

A revision of a chart published in 1952. Chart includes complete generalized section of surface and subsurface rocks of Kansas. Notes in italics call attention to significant deviations from average lithology or thickness. Section is arranged in 5 columns on 25 x 38 in. sheet.--R. H. King.

2-1346. Deasy, George F., and Phyllis R. Griess. ATLAS OF PENNSYLVANIA COAL AND COAL MINING: PART I, BITUMINOUS COAL: Pennsylvania State Univ., Mineral Industries Expt. Sta., Bull. no. 73, 68 p., maps, Dec. 1959.

This paper-backed atlas brings together selected data on Pennsylvania's bituminous coal resources and coal-mining industry and presents them in graphic form. Included are maps dealing with geological, historical, engineering, economic, production, employment, safety, and transportation facets of the subject.

The approximately 100 maps, most of which are drawn to scales of 1 in. to 32 or 50 mi. are arranged in 6 groups. Introductory maps represent Pennsylvania's relative position among states in the mineral- and coal-mining industries of the United States. A second group of maps deals with Pennsylvania's bituminous coal fields as well as selected coal seams within those fields, and a third group analyzes the composition and heat value of the state's bituminous coal. The fourth group of maps is devoted to employment and labor factors in the bituminous industry, and the fifth is concerned with mines, mining methods, and accidents. A final group represents the production and shipment of coal from the state's coal fields.

The authors plan to prepare a companion volume to the above atlas that will deal with anthracite in Pennsylvania.--J. D. Ridge.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Structural Geology 2-1393; Stratigraphy 2-1420; Sedimentary Petrology 2-1564; Geohydrology 2-1577, 2-1578; Mineral Deposits 2-1585.

2-1347. Ross, Stewart H. CÉLORON-CARQUEVILLE AREA, ABITIBI-EAST AND ABITIBI-WEST ELECTORAL DISTRICTS: Quebec, Dept. Mines., Geol. Rept. 89, 18 p., 2 illus., on pl., geol. map (in pocket), scale 1:63,360, 1959, 8 refs.

This area (49°-49°15'N. 78°20'-78°45'W.), mapped in 1951, is situated within the clay belt of the Abitibi region, and bedrock exposures are rare. All consolidated rock is Precambrian. About 60% of the area is underlain by Keewatin volcanic, intrusive, and sedimentary rocks and the remainder by later intrusive rocks. The southern and western quarters of the area are underlain mainly by Keewatin rocks, and the northwestern third by later granite. The Keewatin rocks are mainly andesitic to basaltic

lavas, with associated gabbroic to dioritic intrusive rocks. Agglomerates and tuffaceous sedimentary rocks are present locally. The granite in the northwestern part of the area is part of a large mass lying mainly to the N. of the area, between Harricana and Turgeon rivers. A syenite intrusion towards the southwestern corner of the area is part of a mass that extends some 4 mi. to the S. Other minor intrusions consist of diorite and granodiorite; the latest, referred to the Keweenawan, are of diabase and gabbro. Hybrid rocks, consisting of injection gneiss, contact breccia, and diorite, occur along the contacts between the northwestern granite mass and the Keewatin volcanics.

Some prospecting has been done in various parts of the area since 1940, and some copper showings have been found.--From auth., p. 1, 4, 13.

2-1348. Tiphane, Marcel. CHASTE-MAZARIN AREA, ABITIBI-EAST ELECTORAL DISTRICT: Quebec, Dept. Mines, Geol. Rept. 88, 15 p., 8 illus. on 4 pls., geol. map (in pocket), scale 1:63,360, 1959, 12 refs.

The map-area (49°-49°15'N. 77°45'-78°20'W.), covering 550 sq. mi., was examined in 1948 and 1949. It may be divided into 2 parts along a N.-S. line near the Dalet-Maizerets and Mazarin-Glandelet township boundaries. E. of this line outcrops are scarce and scattered, and most contacts can only be approximated. They are more abundant along Harricana River, Coigny River, and one of its tributaries, and on low hillocks in the central and northeastern parts of the area. Outcrops are more common in the second or western part, a belt 5 or 6 mi. wide towards the western boundary of the area.

Beaches composed of rounded pebbles of different rock types were observed along the slope of a few hills. Their elevations, according to barometric measurements, is 150 ft. above the level of Octave River.

All the consolidated rocks are Precambrian. Keewatin-type volcanic rocks and slates, the latter probably of sedimentary origin, occupy about 85% of the area and are intruded by younger granitic masses and by diabase dikes. Feldspar porphyry, aplite, and pegmatite dikes are also found in places. Peridotite occurs in the N.-central part of the area and is assumed to be postvolcanic in age.

Granitic rocks form a stocklike mass near the northwestern corner, cropping out over an area of about 4 1/2 sq. mi., and a batholithic mass near and along the southern boundary in a zone up to 3 mi. wide. The batholithic mass seems to be the extension of the "Bernetz gneiss." A small area underlain by granitic rocks diagonally cuts the NE. corner and appears to join with the granitic masses of Harricana and Bell rivers.--From auth., p. 4-5.

During 1957 and 1958, a group of mining companies and syndicates covered most of the area by airborne magnetic and electromagnetic surveys supplemented, in some cases, by ground surveys. A limited amount of diamond drilling was also done, the results of which appear to have been inconclusive. --J. E. Gilbert.

2-1349. Churkin, Michael, Jr., and Ralph L. Langenheim, Jr. SILURIAN STRATA OF THE KLAMATH MOUNTAINS, CALIFORNIA: Am. Jour. Sci., v. 258, no. 4, p. 258-273, 2 illus., map, 4 secs., Apr. 1960, 11 refs.

A eugeosynclinal suite comprising shale, volcanic graywacke, quartz arenite, bedded chert, limestone, and tuff crops out along Willow Creek, W. of Gazelle, California. The limestone and associated interbeds of shale contain Silurian trilobites, brachiopods, and corals. The bulk of the sequence, however, consists of unfossiliferous sedimentary rocks beneath the limestone. Trilobites in the limestone belong to genera previously reported from eastern North America, but the assemblage appears most closely related to Middle and Upper Silurian faunas of Alaska and Asia.

Silurian sedimentary rocks are succeeded in thrust fault contact by phyllite and semischist in the western part of the area. These metamorphic rocks have been derived from sedimentary rocks similar to those of the Silurian sequence chiefly by regional cataclastic deformation. Small bodies of diorite and quartz diorite and a large pyroxenite-peridotite pluton intrude both the sedimentary and metamorphic rocks. In addition Tertiary and/or Quaternary basalt flows and alluvium locally truncate all rocks

Relatively open folds and high-angle faults generally trending N. characterize structural patterns within the sedimentary rocks in marked contrast to a complex pattern of crumpling and shearing in the strongly lineated metamorphic rocks. In addition the thrust plane is deformed by broad open folds plunging gently NW. Thus it is possible to infer at least 3 periods of diastrophism in this area.--Auth.

2-1350. Woodford, A.O. BEDROCK PATTERNS AND STRIKE-SLIP FAULTING IN SOUTHWESTERN CALIFORNIA: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 400-417, map, 1960, 59 refs.

In southwestern California the pre-Turonian bedrock may be divided into 8 units, which may then be used to distinguish 3 rock belts. One belt comprises the glaucophane-bearing rocks near the shore, a second is characterized by quartz-rich graywackes, and the third, which is farthest NE., contains limestones. The second and third belts include Mesozoic volcanics and extensive Cretaceous quartz plutonites. The bedrock mass has been disrupted by faults, some of which have been the loci of strike slips measurable in tens of miles. Much greater displacements have also been suggested. The simpler of these suggestions seem inconsistent with the distribution of the extrusive and intrusive Mesozoic igneous rocks. Perhaps on some faults 2 slip solutions are possible. In such cases tentative choices may be made by the use of the rule Disjunctiones minimae, disjunctiones optimae.--Auth.

2-1351. Vanderpool, Robert E. GEOLOGY OF THE FEATHERSTON AREA, PITTSBURG COUNTY, OKLAHOMA: Oklahoma Geol. Survey, Circ. 53, 36 p., 9 illus., 2 maps (col. geol. map in pocket), 1960, 33 refs.

Rocks of the upper part of the McAlester formation, the Savanna formation, and the lower part of the Boggy formation [all Pennsylvanian] crop out in the area. Three anticlines and 2 synclines are the major structural features. Coal has been produced and is now of little importance. Small gas fields are yielding natural gas from the Hartshorne sandstone [Pennsylvanian].--Auth.

2-1352. Gould, Wilburn J. GEOLOGY OF THE NORTHERN NEEDLE RANGE, MILLARD COUNTY, UTAH: Brigham Young Univ., Dept. Geology, Brig-

am Young Univ. Research Studies, Geology Ser., . 6, no. 5, 47 p., 8 pls. incl. illus., fold. geol. ap, sec., Aug. 1959, 32 refs.

The Needle Range lies in the extreme southwest- rn part of Millard County, approximately 25 mi. S. f Garrison. State Highway 21 bounds the area on he N., Antelope Valley on the E., the Millard- eaver county line on the S., and the Utah-Nevada tate line on the W.

The exposed stratigraphic section, aggregating lightly more than 8,000 ft., includes rocks from Middle Devonian to lower Permian age. The upper art of the Guilmette limestone and Pilot shale, a ombined thickness of 1,800 ft., represents the evonian system. Mississippian strata aggregate ore than 3,000 ft. and include the upper part of he Pilot shale, Joana limestone, Chainman shale, nd the Illipah formation. The Pennsylvanian system ncludes the lower 2,000 ft. of Ely limestone. Only he basal Wolfcampian part of the Permian system s present, represented by 690 ft. of the upper Ely imestone and 1,000 ft. of the Arcturus limestone.

An asymmetrical syncline forms the major tructural feature of the range. Thrust plates mov- g in a NE. direction have overridden the W. limb. he northwestern part of the range has been involved a major fan fold. The folds and accompanying hrust faults probably formed during the various hases of the Laramide orogeny. Numerous normal ults occur throughout but have only minor dis- lacement. Flow rock in the SE. indicates a slight astward tilting of the region.

Structural complexities possibly make the im- ediate area unfavorable for accumulation of gas nd oil.--Auth.

-1353. Bushnell, Vivian, ed. SCIENTIFIC TUDIES AT FLETCHER'S ICE ISLAND, T-3, 1952- 955. VOLUME I: U.S. Air Force, Cambridge Re- earch Center, Geophysics Research Directorate, eophys. Research Papers, no. 63, 219 p., illus., ap, profiles, diags., graphs, tables, Sept. 1959, efs.

Scientific studies based on field investigations at Fletcher's Ice Island T-3 during the period 1952 to 1955 are reported, with appendixes containing data tables. Included are general bathymetry, sub-bottom seismic studies, gravity studies, oceanographic observations, ice movement studies, micropaleontological and lithological analysis of sediment cores, general Arctic Ocean biology, detailed studies of certain marine animals, tritium measurements of ice, and O isotope measurements on sediment cores. In addition to the works of Air Force Cambridge Research Center scientists and contractors, the series includes studies prepared by, and for, several U.S. Government agencies.

The following papers are included in this report.

2. GEOMORPHOLOGY

e also: Geologic Maps 2-1310, 2-1313, 2-1344; Stra- graphy 2-1418, 2-1419; Engineering Geology 2-1618, 1619.

-1354. Tanner, William F. NUMERICAL COM- ARISON OF GEOMORPHIC SAMPLES: Science, 131, no. 3412, p. 1525-1526, May 20, 1960, ref.

The distribution of elevations representing a re- on can be shown as a cumulative frequency curve lotted on probability paper. Many elevation distri- tions are "zig-zag" curves which can be repre- nted conveniently by measures of skewness and rtosis. A plot of skewness versus kurtosis per- its the recognition of 6 major, non-Gaussian forms, th countless gradations.--Auth.

1355. Rocky Mountain Nature Association. LACIERS IN ROCKY MOUNTAIN NATIONAL PARK: p., 9 illus., Estes Park, Colorado, 1959.

A brochure intended for visitors to Rocky Moun- in National Park, Colorado. It describes in non- chnical terms the action of glaciers, their forma- on and movement. Also given are brief descriptions d directions for reaching the following glaciers: Andrew's, Tyndall, Sprague, Rowe, and Taylor.--M. Russell.

2-1356. Johnson, Arthur. U.S. GEOLOGICAL SURVEY AND U.S. NATIONAL PARK SERVICE GLACIER OBSERVATIONS, GLACIER NATIONAL PARK, MONTANA, 1959: U.S. Geol. Survey, Repts., Open-File Ser., no. 507, 23 p., 2 illus., fold. map-profiles, 3 tables, March 1960.

Data recorded during the 1959 season on Grinnell and Sperry glaciers in Glacier National Park are presented. Measurements were made of surface changes, movement, recession, precipitation, and runoff.--M. Russell.

2-1357. Rutten, M.G. ICE-PUSHED RIDGES, PERMAFROST AND DRAINAGE: Am. Jour. Sci., v. 258, no. 4, p. 293-297, 2 maps, Apr. 1960, 8 refs.

Ice-pushed ridges in regional development are the main glacial characteristics of the northwestern European plain. They were formed during the Riss glaciation and consist of preglacial material pushed

up into long, straight or curved ridges with an imbricate structure. They developed as a consequence of the formation of a thick permafrost layer in front of the advancing ice sheet.

Ice-pushed ridges of such a regional development are absent from the northern plains of the United States. It is thought that a relative difference in drainage pattern - away from the ice front in the U. S. A. and toward the ice front in Europe - can be held responsible. The presence of ice-pushed ridges in northwestern Canada, where again the drainage is toward the ice front, and their absence in the European Würm glaciation, where outward drainage prevailed, corroborates this theory.--Auth.

2-1358. Marcus, Melvin G. PERIODIC DRAINAGE OF GLACIER-DAMMED TULSEQUAH LAKE, BRITISH COLUMBIA: Geog. Rev., v. 50, no. 1, p. 89-106, 6 illus., 2 maps, 2 secs., 4 diags., 3 graphs, 2 tables, Jan. 1960, approx. 15 refs.

Ice-dammed Tulsequah Lake has been subject to periodic (usually annual) summer outbursts beneath the 4 1/2 mi. surface of its glacier barrier for over 50 years. The formation and morphology of this lake type is associated with specific phases of climate and glacier retreat common to the North Pacific coast of North America during the last 100 years. At its maximum dimensions (1910-1920), the lake was 195 m. deep and discharged about 239 billion gallons of water. In July 1958, it was 73 m. deep, discharging about 60 billion gallons in a 4-day period. Bathymetric mapping and geobotanical techniques provided fair accuracy.

Drainage frequency is a direct response to climate and ice barrier height. Drainage mechanics are more complex. Physical conditions prevented close examination of water inlets at the foot of the ice dam. Changes in glacial structure and measurement of escape flow, and observation of outlets at the glacier terminus do, however, indicate an hypothesis. It is believed that ice flotation allows access of the water to remnant subsurface pipes. Although the ice barrier resettles, continuous flow is established, and escaping water enlarges the tunnels by melting. At the completion of drainage the pipes begin to close gradually, and barrier outlets are plugged during the autumn freeze. When the lake refills, the process is repeated.--Auth.

2-1359. Terasmae, Jaan, and Owen L. Hughes. GLACIAL RETREAT IN THE NORTH BAY AREA, ONTARIO: Science, v. 131, no. 3411, p. 1444-1446, map, May 13, 1960, 10 refs.

Geological and palynological studies in Ontario and Quebec, supported by radiocarbon dates, suggest that the opening of the North Bay outlet and the initiation of the Stanley-Chippewa stages in the Huron and Michigan basins took place 10,000 to 11,000 years ago.--Auth.

2-1360. Tipton, Merlin J. A NEW GLACIAL DRIFT SHEET IN SOUTH DAKOTA?: South Dakota Acad. Sci., Proc., v. 38 (South Dakota, State Univ., Bull., ser. 60, no. 2), p. 45-48, map, table, 1959, pub. 1960, 11 refs.

The glacial drift in the Big Sioux River valley of South Dakota between Sioux Falls and Watertown has been previously mapped as deposits of 1 glacial age or subage. Chamberlin, Rothrock and Newcombe, Leverett, and Rothrock and Otton mapped the drift as Kansan, but Flint mapped it as Iowan. On the basis of topographic evidence discovered in 1958 in this area, it is believed that 2 drifts rather than 1 are present. The northern part of the area is believed to be Iowan(?) in age and the southern part Illinoian(?).--F. V. Steece.

2-1361. Cook, Frank A. SELECTED BIBLIOGRAPHY ON PERIGLACIAL PHENOMENA IN CANADA: Canada, Dept. Mines & Tech. Surveys, Geog. Branch, Bibliog. Ser. 24, 23 p., 1959.

This bibliography presents 93 selective references to periglacial phenomena in Canada in the form of annotations and abstracts.--Auth.

2-1362. Lofgren, Ben E. NEAR-SURFACE LAND SUBSIDENCE IN WESTERN SAN JOAQUIN VALLEY, CALIFORNIA: Jour. Geophys. Research, v. 65, no. 3, 1053-1062, 9 figs. incl. 2 illus., 2 maps, diags., graphs, March 1960, 4 refs.

Numerous evidences of land subsidence have been observed on unusual soils in the San Joaquin Valley immediately after the application of water. This subsidence results in extensive settling and cracking of soil along ditches and in irregular, undulating topography in irrigated areas. Experiments on quarter-acre test plots are being made to determine the nature and magnitude of near-surface subsidence on different types of alluvial deposits. After 27 months of observation of test plot B, to Dec. 29, 1958, surface bench marks had settled an average of 10.50 ft.; a bench mark anchored at a depth of 25 ft. had settled 9.44 ft.; a bench mark at 50 ft., 8.13 ft.; a bench mark at 75 ft., 6.13 ft.; a bench mark at 100 ft., 3.93 ft.; and a bench mark at 150 ft., 0.39 ft.

Infiltration at a continuing rate of 0.20 ft. of water per day for a 15-month period of inundation was more than sufficient to fill the pore space beneath the test plot to the wetted front, and considerable lateral spreading of the water occurred. Core samples collected before and during the spreading operation show the increase in density and moisture content of the subsurface deposits. The low field density and extreme dryness of the alluvial deposits apparently are 2 important factors in land subsidence due to application of water.--Auth.

2-1363. Tanner, William F. HELICOIDAL FLOW, A POSSIBLE CAUSE OF MEANDERING: Jour. Geophys. Research, v. 65, no. 3, p. 993-995, 2 diags., March 1960, 4 refs.

Sediment-free model streams, suspended from the lower sides of nearly horizontal glass plates, meander in the same way as do alluvial rivers. Meandering cannot, therefore, be ascribed to granular bed load. It is suggested that an alternative causative mechanism is helicoidal flow, which, in turn, is the product of turbulence within the stream, as Einstein and Li have pointed out.--Auth.

2-1364. Dury, G.H. MISFIT STREAMS: PROBLEMS IN INTERPRETATION, DISCHARGE, AND DISTRIBUTION: Geog. Rev. v. 50, no. 2, p. 219-242, map, 2 diags., Apr. 1960, 38 refs.

Misfit streams are shown to be regionally distributed, and river capture is rejected as a general cause of their condition. Large meandering channels beneath the alluvium of misfit streams are

nterpreted as former stream beds, largely infilled fter a change in regimen caused by a change of limate. Statistical analysis of dimensions of chanels, of valley meanders, and of stream meanders s used to indicate, within fairly wide limits, the rder of reduction in near-bankfull discharge which s expressed in the misfit condition. Data from very mall catchments show that present streams, even in onditions highly favorable to rapid surface runoff, il to develop meanders comparable in size, area r area, with valley meanders, while data from ery large catchments demonstrate the unitary ature of the problem discussed. Tentative or reliminary comments and suggestions are made on ating and on distribution.--Auth.

-1365. Hack, John T. INTERPRETATION OF ROSIONAL TOPOGRAPHY IN HUMID TEMPERATE EGIONS: Am. Jour. Sci., v. 258-A (Bradley Volme), p. 80-97, 2 maps, profile, sec., 1960, 48 efs.

Since the period 1890 to 1900, the theory of the eographic cycle of erosion has dominated the cience of geomorphology and strongly influenced e theoretical skeleton of geology as a whole. Some the principal assumptions in the theory are unealistic. The concepts of the graded stream and of iteral planation, although based on reality, are misplied in an evolutionary development, and it is unkely that a landscape could evolve as indicated by e theory of the geographic cycle.

The concept of dynamic equilibrium provides a ore reasonable basis for the interpretation of topoaphic forms in an erosionally graded landscape. ccording to this concept every slope and every hannel in an erosional system is adjusted to every her. When the topography is in equilibrium and rosional energy remains the same, all elements the topography are downwasting at the same rate. ifferences in relief and form may be explained in rms of spatial relations rather than in terms of an volutionary development through time. It is recogized however that erosional energy changes in space well as time, and that topographic forms evolve energy changes.

Large areas of erosionally graded topography in mid regions have been considered to be "maturely ssected peneplains." According to the equilibrium eory, this topography is what we should expect as e result of long continued erosion. Its explanation oes not necessarily involve changes in base level. diments in humid regions and some terraces are so equilibrium forms and commonly occur on a wland area at the border of an adjacent highland.-uth.

1366. Radforth, Norman W., and Lynda S. guitan. DEFINITIVE MICROFOSSILS PERTINENT D PHYSIOGRAPHIC DIFFERENCE IN MUSKEG: oyal Soc. Canada, Trans., Sec. 5, v. 53, p. 35-, illus., table, 1959, 8 refs.

It is commonly difficult to assign muskeg areas specific categories because of admixture of cover pes. Microfossil analysis was made of muskeg eas at Copetown, Ontario, and Fort Churchill, Manitoba, in an attempt to reveal the primary organization. Spore and pollen analyses were made of samples taken at 2.5-cm. increments. Ponding is a major factor in mixed cover areas.--M. Russell.

2-1367. Plapp, John E., and James P. Mitchell. A HYDRODYNAMIC THEORY OF TURBIDITY CURRENTS: Jour. Geophys. Research, v. 65, no. 3, p. 983-992, 2 figs., 2 tables, March 1960, 7 refs.

A theory of steady-state turbidity currents along sloping and horizontal ocean or lake bottoms is developed on the basis of hydrodynamic boundary-layer assumptions. The theory is applied to the Grand Banks turbidity current of 1929; reasonable values of current thickness and sediment content are obtained, as well as satisfactory agreement between observed and calculated velocities.--Auth.

2-1368. Hunkins, Kenneth L., Maurice Ewing, Bruce C. Heezen, and Robert J. Menzies. BIOLOGICAL AND GEOLOGICAL OBSERVATIONS ON THE FIRST PHOTOGRAPHS OF THE ARCTIC OCEAN DEEP-SEA FLOOR: Limnology & Oceanography, v. 5, no. 2, p. 154-161, 15 illus., Apr. 1960, 4 refs.

The first series of Arctic bottom photographs give the following indications regarding conditions on the Arctic sea floor: Bottom life appears to be less abundant than in the Atlantic Ocean at similar depths. Loose rocks are more numerous. Ripples seem to be less abundant in the Arctic area photographed than they do at comparable depths in the Atlantic. A bottom current of 0.3 to 0.6 cm./sec. is indicated from movements of sediment clouds. The area is abundantly supplied with curious short "tracks" of uncertain origin. Small irregular holes in the pictures probably represent holes produced by ice-rafted stones and pebbles.--Auth.

2-1369. Hare, F. Kenneth. A PHOTO-RECONNAISSANCE SURVEY OF LABRADOR-UNGAVA: Canada, Dept. Mines & Tech. Surveys, Geog. Branch, Mem. 6, 83 p., 14 pls. 11 figs. incl. 2 maps, 5 tables, 1959, 38 refs.

A terrain analysis of Labrador-Ungava based on aerial photography. In developing methods of interpretation many thousands of square miles of Labrador-Ungava were covered on the ground and many thousands of air miles flown across it. The following physiographic divisions are recognized:

A. Bedrock-controlled plateau elements: 1) western plateau belt, 2) eastern plateau belt, 3) southeastern plateau belt.

B. Upland areas - massifs: 1) center of Kaniapiskau massif, 2) NE. Labrador massif, 3) Mealy Mountain massif, 4) Red Wine-Romaine-Fleur-de-Mai axis, 5) Laurentide massif.

C. Upland areas - Appalachian type: 1) Cape Smith ranges, 2) Labrador trough, 3) Naskaupi ranges, 4) Otish ranges, 5) Belcher-Nastopoka belt.

D. Drift-covered belts: 1) the Lake plateau, 2) southeastern drift belts - Moraine-Mecatina-Hamilton-Naskaupi, Double Mer belts, 3) Whale River depression and associated drift belts W. of the Labrador trough, 4) the Eastmain belt.--F. A. Cook.

See also: Areal and Regional Geology 2-1350; Stratigraphy 2-1404, 2-1415; Geophysics 2-1483, 2-1506, 2-1507; Mineral Deposits 2-1587.

2-1370. Kravchenko, G.G. AN EXAMPLE OF PLASTIC DEFORMATION OF LIMESTONES IN TECTONIC FRACTURE ZONES: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 3, p. 75-85, 8 figs. incl. 4 illus., map, pub. 1959, 10 refs.

In the area of the Kansk polymetallic deposit (southwestern part of Kirghiz SSSR), widely distributed lower Carboniferous limestone (Visean stage) contains numerous fragments of serpentinite. The limestone containing these fragments, that is, the limestone-serpentinite dikes, occurs as linear zones in serpentine rocks. Mapping and study of their structural details led to the conclusion that these formations originated during the process of plastic flow of the limestone in the tectonic fracture zones. --Auth.

2-1371. Griggs, David T., and John Handin, eds. ROCK DEFORMATION (A SYMPOSIUM): Geol. Soc. America, Mem. 79, 382 p., illus., diags., graphs, tables, 1960, approx. 250 refs.

This volume contains most of the papers presented at the Symposium on Rock Deformation held in conjunction with the Annual Technical Conference of the Institute of Geophysics, University of California, Los Angeles, Nov. 1956. In most instances these papers have been expanded, extended, and revised as a result of new ideas and further experimental work. This collection of papers gives some recent results of most of the active workers in the United States in experimental rock deformation and also presents several new theoretical contributions. Each paper reports research which was separately conceived and executed and so is necessarily specialized and detailed. Throughout there is the common goal of a better understanding of the mechanics of the deformation of rocks in the earth.--From pref.

Each of the 13 papers included in the symposium is abstracted separately below in the order in which it appears in the book.

2-1372. MacDonald, Gordon J. F. ORIENTATION OF ANISOTROPIC MINERALS IN A STRESS FIELD (In: Griggs, David T., and John Handin, eds. Rock Deformation (A Symposium): Geol. Soc. America, Mem. 79, p. 1-8, 1960)

The equilibrium orientation of an anisotropic mineral in a stress field is one in which the potential energy of the external forces plus the potential energy of deformation is minimized. For materials obeying a linear elastic stress-strain law, the minimum total potential energy is equivalent to a maximum Helmholtz free energy in an isothermal system or a maximum internal energy in an adiabatic system. The minimum potential-energy theorem is applicable to the orientation of minerals in rocks undergoing plastic deformation provided temperature and elastic strain are sufficient parameters to describe the thermodynamic state of the mineral undergoing isothermal plastic flow.--Auth.

2-1373. Brace, William F. ORIENTATION OF ANISOTROPIC MINERALS IN A STRESS FIELD: DISCUSSION (In: Griggs, David T., and John Handin, eds. Rock Deformation (A Symposium): Geol. Soc. America, Mem. 79, p. 9-20, 5 diags., 3 tables, 1960)

Based on MacDonald's thermodynamic prediction that minerals should so orient that strain energy is maximized, the preferred orientations of calcite, high and low quartz, and ice are calculated for a stress field consisting of a single component. The following planes should be approximately normal to the stress: ice and calcite, the planes $\{10\bar{1}1\}$; high quartz, the planes $\{10\bar{1}2\}$; and low quartz, the planes $\{02\bar{2}1\}$. A number of grains at equilibrium will have c-axes which occupy girdles about the single-stress component.

The equations for strain energy of hexagonal minerals in a stress field of 3 different principal stresses are derived and applied to the orientation of ice (-2°C.). The preferred orientation depends upon ratios of principal stresses and upon stress difference and confining pressure independently. The c axes of grains tend to lie on small-circle girdles about the unique principal stress in a uniaxial stress field.--Auth.

2-1374. Griggs, David T., and M.S. Paterson, Hugh C. Heard, and Francis J. Turner. ANNEALING RECRYSTALLIZATION IN CALCITE CRYSTALS AND AGGREGATES (In: Griggs, David T., and John Handin, eds. Rock Deformation (A Symposium): Geol. Soc. America, Mem. 79, p. 21-37, 12 illus., 6 diags., table, 1960)

Annealing recrystallization has been produced in cold-strained single crystals of calcite, fine-grained undeformed aggregates, highly sheared aggregates, and in Yule marble deformed cold under controlled conditions.

The critical temperature for recrystallization of Yule marble is about 500°C. In our limited experience annealing time does not seem to influence recrystallization.

In contrast to recrystallization during shear strain (syntectonic recrystallization), which develops high preferred orientation, annealing recrystallization tends to produce a random orientation, but traces of a preferred orientation inherited from the original material remain. Textures of calcite fabrics completely recrystallized by annealing closely resemble granoblastic or porphyroblastic textures of metamorphic rocks.

Recrystallization of calcite is similar in every respect that we have yet explored to recrystallization of metals. Water and CO_2 have not affected the process in our experiments.--Auth.

2-1375. Griggs, David T., Francis J. Turner, and Hugh C. Heard. DEFORMATION OF ROCKS AT 500° TO 800°C. (In: Griggs, David T., and John Handin, eds. Rock Deformation (A Symposium): Geol. Soc. America, Mem. 79, p. 39-104, 22 illus., (1 col.), 48 diags., 6 tables, 1960)

Extensive experiments on the deformation of rocks at temperatures from 25° to 800°C. have been performed in triaxial-test apparatus at 5 kb. confining pressure and in shearing apparatus at pressures to 20 kb. A variety of rocks, crystals, and mixtures have been tested, including peridotite, pyroxenite, basalt, granite, dolomite, marble, and quartz crystals and aggregates.

Strength is reported as a function of temperature. High quartz is found to be very strong. Peridotite, pyroxenite, and granite have nearly the same strength over the entire temperature range - 20 kb. at 25°C. and 7 kb. at 800°C. Basalt has a similar strength to 600°C., but its strength decreases rap-

dly at higher temperatures. Dolomite is weaker han these rocks at low temperature but at 500°- 00°C. has nearly the same strength as peridotite, yroxenite, and granite. Marble is much weaker at ow temperature and decreases in strength more apidly than the other rocks as temperatures in- reases.

The principal mechanism of deformation of iopside was found to be {100} translation. Grains f enstatite highly deformed at 500°C., 5 kb. locally nvert to clinoenstatite. The mechanism of deforma- ion of olivine was not identified.

Stress-strain curves of calcite single crystals hange character at 500°-600°C. At 600°C., f trans- ation becomes important, and at 800°C. basal glide ay occur. At 800°C., twinning is little easier nan r translation, which is still the easiest trans- ation. This large change in the relative ease of ranslation and twinning at high vs. low temperature as important consequences in the deformation of narble at 800°C.

Syntectonic recrystallization reaches a maximum t 600°C. in marble deformed at 3% per minute. t a lower strain rate the maximum syntectonic re- rystallization seems to occur at a lower tempera- ure. The recrystallized grains show a pronounced rientation with the c-axes parallel to the maximum rincipal compressive stress. Water and CO_2 do ot affect this recrystallization in our experience to ate. The recrystallization observed in these xperiments is thought to be of the same type as that hich occurs in metamorphic marmorization.

Only very limited plastic deformation of quartz as been observed at 500° and at 800°C., 5 kb. The echanism could not be determined. High preferred rientations have been developed in quartz in shear- ng experiments, particularly when the quartz rystallized from an amorphous phase subject to arge shear stress and strain.--Auth.

-1376. Maxwell, John C. EXPERIMENTS ON OMPACTION AND CEMENTATION OF SAND (In: riggs, David T., and John Handin, eds. Rock De- ormation (A Symposium): Geol. Soc. America, Mem. 9, p. 105-132, 12 illus., 11 diags., 7 tables, 1960)

Compaction and cementation of quartz sands and atural sandstones have been studied experimentally nder conditions simulating deep burial. Approxi- hately 230 experiments, lasting a few hours to 100 ays, were successfully completed.

Compaction, resulting in loss of porosity, comes bout largely by mechanical fracturing, rotation, nd interpenetration of grains. High temperatures nd the presence of distilled water and alkaline aline waters facilitate compaction. Flowing solu- ons are more effective in this respect than are tatic solutions.

Cementation occurs more or less independently f compaction. Again, flowing solutions are the ost efficacious. Very little cementation resulted om any of the experiments with distilled water. ith sea water and saline-formation waters the egree of cementation is a function of temperature nd develops with increasing rapidity above 270°C. it occurs at all, the cementation is apparent ithin the first 24 hours.

The fabric of many natural sandstones suggests at compaction has been brought about primarily by olution of quartz grains at points of contact. We ere unable to demonstrate this process experimen- lly, however, although it may have occurred to me degree in experiments at high temperatures with flowing solutions. One experiment involving an alkaline solution of colloidal silica duplicates the fabric of a natural sandstone quite closely, in that the fractures resulting from compaction apparently have been healed by deposition of secondary quartz. It is suggested that mechanical straining, fracturing, and crushing of quartz grains at points of contact, followed by solution of the strained and fractured quartz and healing of fractured grains, may be important in consolidation of natural sandstones.

An anomalous increase in apparent compressive strength of quartz with rising temperature was observed in the interval between 235° and 270°C. This effect is possibly related to incipient plastic deformation of the quartz grains and may be a factor in the preservation of porosity of deeply buried sandstones.--Auth.

2-1377. Borg, Iris, Melvin Friedman, John Handin, and Donald V. Higgs. EXPERIMENTAL DEFORMATION OF ST. PETER SAND: A STUDY OF CATACLASTIC FLOW (In: Griggs, David T., and John Handin, eds. Rock Deformation (A Symposium): Geol. Soc. America, Mem. 79, p. 133-191, 10 illus., 58 diags., 4 graphs, 14 tables, 1960)

In order to make a quantitative study of a purely cataclastic deformation, jacketed cylindrical specimens of dry St. Peter quartz sand of different grain sizes have been deformed under uniform confining pressure and differential load. Results presented illustrate the influence of the deformation on porosity, pore size, grain size, grain fracturing and orientation, and strength. The present experiments, conducted under deliberately restricted conditions, are intended as a first step toward an adequate understanding of the complicated problem of sandstone deformation.

Undeformed St. Peter sand grains are unfractured to slightly fractured; contain planes of liquid and gas inclusions which exhibit a decided preference for the prism zone; exhibit a predominance of grains with no undulatory extinction as well as grains which are slightly, moderately, and highly undulatory; contain very few grains showing "deformation" lamellae; have an intercept ration of 1:1.3:1.7, and a high intercept sphericity (0.77 to 0.79); and appear to have grain shapes controlled by r $\{10\bar{1}1\}$, z $\{01\bar{1}1\}$, and the prisms. The undeformed sand aggregates exhibit an apparent elongation so that the long axes of the grains tend to lie parallel to the circular section. In addition, the aggregates show a tendency for the optic axes of the grains to form a girdle parallel to the circular section.

Fracturing is the most conspicuous feature of the deformed sands. The fracture pattern of specimens deformed under uniform pressure is random. Fracture-orientation patterns reflect the symmetry of the deformation under differential loading conditions. In compressed specimens the fractures tend to lie at small angles to the direction of loading and are probably shear fractures. In extended specimens the late-formed fractures tend to lie normal to the axis of extension and are most probably tensile fractures.

Apparent elongation and optic-axis orientations for compressed samples are much like those of undeformed sands. In extension, however, the apparent elongations of the grains undergo a progressive rotation through 90° from their initial positions. This accompanied by a similar shift in optic-axis orientations and therefore indicates that bodily rotation of grains does occur.

There is no evidence that the experimental de-

formation has produced any "deformation" lamellae or that the over-all undulatory extinction index has been changed. The percentage of moderately and highly undulatory grains decreases, however, indicating that these grains are particularly susceptible to fracturing.

For sands of uniform grain size the coarsest sand (250-300 microns) exhibits the greatest compressibility (uniform confining pressure), which correlates with the facts that this sand also exhibits the greatest reduction in porosity, median pore size, median grain size, and the lowest percentage of unbroken grains. The coarsest sand is the strongest in triaxial tests (differential loading). On the other hand, the finest sand (105-125 microns) is the least compressible; it exhibits the least reduction in porosity, median pore size, and median grain size, and the largest percentage of unbroken grains, and it is the weakest in triaxial tests.

It is significant that uniform loading (approximately simulating an overburden pressure alone) does not reorient the fabric of the sands, whereas differential loading results in preferred orientations of fractures, optic axes, and apparent grain elongations, all of which reflect the orientations of the principal stresses across the boundaries of the specimens. This suggests that petrographic studies of natural sands may be used to distinguish between the effects of overburden and of tectonics.--Auth.

2-1378. Heard, Hugh C. TRANSITION FROM BRITTLE FRACTURE TO DUCTILE FLOW IN SOLENHOFEN LIMESTONE AS A FUNCTION OF TEMPERATURE, CONFINING PRESSURE, AND INTERSTITIAL FLUID PRESSURE (In: Griggs, David T., and John Handin, eds. Rock Deformation (A Symposium): Geol. Soc. America, Mem. 79, p. 193-226, 3 illus., 22 diags., 5 tables, 1960)

More than 115 triaxial compression and extension experiments have been performed on the mechanically isotropic, homogeneous Solenhofen limestone to determine the transition from brittle fracture to ductile flow as a function of temperature, confining pressure, and interstitial fluid pressure. Temperature and confining pressures ranged from 25° to 700°C. and from 1 to 7,500 atm.; interstitial fluids included water and carbon dioxide. Strain rates remained constant at 10^{-4}/second. Transitional behavior was arbitrarily defined as that point at which 3-5% strain may be induced without notable loss in cohesion. In dry extension tests, the confining pressure required to induce transitional behavior decreased from 7,300 atm. at 25°C. to about 700 atm. at 700°C. In dry compression tests, the pressure required for the transition was 1,000 atm. at 25°C., decreasing to 1 atm. at 480°C. For transitional behavior in compression tests with interstitial fluids, with increasing confining pressure, the difference between confining pressure and interstitial pressure decreased almost exponentially from 1,000 atm. at 25°C. and 850 atm. at 150°C. to nearly zero at 5,000 atm.

Data for all stress-strain curves are summarized; most stress-strain curves are plotted and compared for a wide variety of test conditions. From these, plots of transition stress or ultimate stress at transition conditions, maximum and minimum principal stresses, and mean stress are derived and reported as a function of temperature.

None of the various theories of strength examined were able to correlate results in compression and extension. The Mohr criterion predicted shear fracture angles within 4° at the brittle-ductile transition for dry compression tests and within 7° for extension tests at temperatures ranging from 25° to 400°C. By applying the Mohr theory, similar angles were predicted within 3° for transitional compression tests with interstitial water at both 25° and 150°C.

The geological implications of these experiments are briefly discussed. Even though the experimental strain rate is vastly greater than tectonic strain rates, the qualitative difference observed between compression and extension would probably apply to naturally deformed limestones. The analogy of compression experiments to reverse faulting and of extension experiments to normal faulting is discussed. In the event that strain rate does not affect the brittle-ductile transition, these experiments predict normal faulting of dry limestone to a depth of 15 km. and reverse faulting to a depth of 3.5 km. Interstitial fluid pressure would increase the depth to which faulting could occur.--Auth.

2-1379. Robertson, Eugene C. CREEP OF SOLENHOFEN LIMESTONE UNDER MODERATE HYDROSTATIC PRESSURE (In: Griggs, David T., and John Handin, eds. Rock Deformation (A Symposium): Geol. Soc. America, Mem. 79, 227-244, 9 diags., 2 tables, 1960)

Stress, strain, and time observations were made of 10 solid cylinders of Solenhofen limestone compressed into the plastic range or beyond rupture; 32 observations were made of transient creep under nearly constant hydrostatic pressure and stress difference. Eighteen creep tests were made on Danby marble, Rutland White marble, and calcite, and 10 creep tests on the punching of Solenhofen limestone discs.

One to six consecutive creep tests on each specimen were made under hydrostatic pressures up to 4,000 bars under stress differences from 3,000 to 8,000 bars at room temperature. Although the data are somewhat inexact and refer only to transient creep (measured for periods less than 3 hours), certain generalizations can be made: 1) The effect of hydrostatic pressure in decreasing the creep rate is demonstrated by the 100-fold decrease in the creep rate per unit stress difference as hydrostatic pressure is increased from 1,000 bars to 2,000 bars. 2) The similarity of creep behavior of obviously highly fractured specimens to those apparently deformed wholly by plastic flow suggests that fracturing is one of the principal mechanisms of creep in limestone. Healing of fractures is indicated by recovery of deformation upon unloading. 3) Two empirical laws were found to satisfy the creep data: a logarithmic relation for strain-time data, $\dot{\epsilon} = kt^{-1}$, and a linear power law for the strain rate-stress difference data, $t\dot{\epsilon} = k_1\sigma_D^{-} k_2$.

A dimensionless strain ration, $t\dot{\epsilon}/\epsilon$ and a dimensionless stress ratio, $(\sigma_z - \sigma_m)/\sigma_m$, were found to be parameters respectively of fracturing and of ductility for limestone.--Auth.

2-1380. Handin, John, Donald V. Higgs, and Joseph K. O'Brien. TORSION OF YULE MARBLE UNDER CONFINING PRESSURE (In: Griggs, David T., and John Handin, eds. Rock Deformation (A Symposium): Geol. Soc. America, Mem. 79, p. 245-274, 14 illus., 11 diags., 7 tables, 1960)

Jacketed cylindrical specimens of Yule marble and calcite single crystals have been twisted at a constant rate of 0.1 radian per minute under confin-

g pressures of 1,000 to 2,750 kg./cm.^{2}, at tempera-
res from 24°C. to 300°C., and under axial loads
0 to 1,000 kg./cm.^{2} Permanent twists of as much
1.6 rad/cm. have been obtained. The yield stress
d ductility of the marble increase with confining
essure and are further enhanced by an axial com-
essive load. The yield stress decreases, and the
ctility increases as the temperature is raised.
rsion under confining pressure alone leads to
nsile fracture across a helical surface which is
erywhere normal to the least principal stress, a
nsion of about 200 kg./ cm.^{2} In specimens under
axial compressive load, failure is by shear frac-
ring approximately parallel to the plane of maxi-
um shearing stress.

Petrographic studies reveal that macroscopically
e shear occurs parallel to circular sections. The
iding elements in the grains of the aggregate and
the single crystals have not yet been delineated,
t the evidence suggests translation gliding on
rtain planes not previously observed in marble
formed under uniaxial compression or extension.
echanical twinning on e {01$\bar{1}$2} is common but can-
t be the predominant flow mechanism.--Auth.

1381. Higgs, Donald V., Melvin Friedman, and
hn E. Gebhart. PETROFABRIC ANALYSIS BY
EANS OF THE X-RAY DIFFRACTOMETER (In:
iggs, David T., and John Handin, eds. Rock De-
rmation (A Symposium): Geol. Soc. America,
em. 79, p. 275-292, illus., chart, 28 diags.,
ole, 1960)

The sample holder designed for adaptation of a
relco X-ray diffractometer to petrofabric analysis
rmits relatively rapid definition of preferred crys-
llographic orientations. A complete diagram is
tained in about 3 hours by examination of one sam-
e. Moreover, diagrams are obtained by plotting
rectly the intensities recorded on a strip chart.
sorption and geometric corrections are unneces-
ry because, by studying hemispherical surfaces,
sorption is held constant, and, by construction of
e sample holder, misalignment problems are
iminated.

Three rocks - Poughquag quartzite, Yule marble,
d Solenhofen limestone - were studied. Orienta-
ons in the quartzite and marble determined by X-
ys are in excellent agreement with fabrics ob-
ined from microscopic measurements. The quartz-
exhibits a preferred a axis as well as a c_v ori-
tation. X-ray diagrams record changes in crystal-
graphic orientations for experimentally deformed
le marble. The limestone, which is too fine-
ained to be studied optically, exhibits a slight
ndency for preferential c_v orientation.--Auth.

1382. Odé, Helmer. FAULTING AS A VELOC-
Y DISCONTINUITY IN PLASTIC DEFORMATION
: Griggs, David T., and John Handin, eds. Rock
formation (A Symposium): Geol. Soc. America,
em. 79, p. 293-321, 25 diags., 1960)

Triaxial loading of certain rocks sometimes re-
lts in faulting without fracture in the ordinary
nse, or sudden displacements. A brief discussion
the theory of brittle fracture of Griffith is given
indicate why it cannot apply to this kind of ductile
lting. Such ductile faulting can be explained by
e theory of plasticity for plane strain. This theory
presented for more general yield conditions than
at of von Mises, and it is assumed that the stress-
rain rate relations can be derived from the yield
condition by a process of differentiation. This formalism is by no means original, but it is little known among geologists. Across certain planes in the plastic mass, discontinuities in the velocity are possible, whereas the stresses remain continuous across these planes. These "characteristic planes" of the velocity equations are identified with the planes of ductile faulting. The results obtained in the theory of plane strain for the von Mises, Coulomb, and Torre yield conditions do not hold for the more general 3-dimensional theory, unless very stringent conditions on the strain rates are satisfied. Smooth characteristic surfaces in the plastic domain are possible only if these conditions are satisfied. Possibly, however, there are yield conditions which lead to smooth characteristic surfaces under weaker restrictions on the strain rates.--Auth.

2-1383. Orowan, E. MECHANISM OF SEISMIC FAULTING (In: Griggs, David T., and John Handin, eds. Rock Deformation (A Symposium): Geol. Soc. America, Mem. 79, p. 323-345, 10 diags., 1960)

According to the classical theory, earthquakes would be caused by fracture, or the release of static friction, followed by sliding between the fault walls and a consequent drop of stress around the fault. At a depth of 600-700 km., where the pressure is about 200,000 bars, the lowest possible estimate of the coefficient of friction (about 1) would demand principal stress differences of the order of 400,000 bars for overcoming the friction of the fault wall and producing a drop in seismic stress. Such high stresses cannot be assumed to exist, if only because the yield stress of the asthenospheric rocks can hardly have an order of magnitude exceeding a few tens or at most hundreds of bars. This estimate is obtained by extrapolation of the observed creep behavior of hard materials with the assumption that the effect of a hydrostatic pressure is similar to that of a correspondingly increased molecular cohesive pressure; its order of magnitude agrees with that of the stress drop estimated from the energies released in earthquakes.

A detailed discussion of this difficulty shows that earthquakes, except at focal depths less than about 5-10 km., cannot arise in the manner implied in the classical theory. The only plausible alternative available at present is that they are due to an instability of plastic deformation (creep) such as gives rise to slip bands. Lüders bands, the Hanson-Wheeler creep-deformation bands, and many other similar phenomena. If creep produces structural changes that accelerate further creep, the deformation concentrates gradually into thin layers in which high flow rates can develop, and finally even shear melting may occur by the heat development due to plastic deformation.

Such a mechanism would explain the sequence structure of earthquakes (fore- and aftershocks). If fracture and frictional sliding are impossible and faulting can occur only by the gradual concentration of creep deformation into thin zones, the stress concentration around the edges of a fault cannot propagate this fault immediately over the entire stressed volume, as would be the case with faulting due to fracture. The fault can extend only after the occurrence of a certain amount of creep leading to progressive strain concentration in the region put under increased stress by the preceding faulting. The first faults in a sequence are likely to be small; after several preparatory faults have thrown a high stress upon a larger volume, however, extensive faulting with larger shocks may develop. Toward

the end of the sequence the intensity of the shocks is likely to decrease again by depletion of stress.

Since creep instability seems at present the only feasible mechanism of deep and intermediate-depth earthquakes, the fact that it is a characteristic of crystalline materials indicates that the seismogenic parts of the Earth's mantle are substantially crystalline.--Auth.

2-1384. Griggs, David T., and John Handin. OBSERVATIONS ON FRACTURE AND A HYPOTHESIS OF EARTHQUAKES (In: Griggs, David T., and John Handin, eds. Rock Deformation (A Symposium): Geol. Soc. America, Mem. 79, p. 347-364, 15 illus., chart, diag., 1960)

Experiments have shown that the deformation of rocks under high confining pressures cannot be described by terms based on ordinary experience. The writers believe there are only 3 fundamental macroscopic processes at work: extension fracturing, faulting, and uniform flow. The first involves separation across a plane of no shear normal to the direction of least principal stress and includes tensile fracture as a special case. Faulting involves a shearing displacement and occurs with or without loss of cohesion. It includes shear fracturing as a special case and may occur along a plane inclined at from a few degrees to 45° to the direction of maximum principal stress. From the standpoint of the stress-strain curve, faulting without loss of cohesion is indistinguishable from flow. (The 3 flow mechanisms - cataclasis, gliding, and recrystallization - cannot always be distinguished either.) Examples of experimental boudins are presented to illustrate these categories of deformation.

The field evidence is that earthquakes are accompanied by shearing displacements and are therefore due to faulting in the general sense. Since stored elastic strain energy is released, there must be at least a momentary and local loss of cohesion. A crack then propagates at close to the speed of sound. For deep-focus earthquakes (down to 700 km.) certainly, and most probably even for shallow disturbances (a few tens of kilometers), ordinary Coulomb fracture is impossible. The internal friction of dry rocks under tens or hundreds of thousands of bars pressure would demand impossibly high shearing stresses of many kilobars. The most reasonable mechanism of energy release at great depth is a phase change, and the most probable phase change is melting.

Calculations suggest that, once a crack or a flaw exists, there is ample elastic energy to propagate the crack by shear melting even if the stress difference is only a few tens of bars. It is, of course, inconceivable that an open crack could exist at depth, so that the most baffling problem is the nature of a flaw of the Griffith type under these conditions. Although it is little more than speculation, we suggest that the flaw may be a pocket of already molten rock or of its more volatile constituents. This idea receives some support from the intimate association of earthquake epicenters and zones of volcanic activity.--Auth.

2-1385. Ball, T.K. A PETROFABRIC ANALYSIS OF A FOLD: Am. Jour. Sci., v. 258, no. 4, p. 274-281, 7 figs., Apr. 1960, 9 refs.

A petrofabric method whereby polygenetic folds can be analyzed is described. The method has been applied to the study of the tectonic history of a fold from the Grampian Highlands of Scotland. An earlier deformation was produced by shearing, followed by accordion folding, utilizing the same S-planes.--Auth.

2-1386. Clark, Lorin D. FOOTHILLS FAULT SYSTEM, WESTERN SIERRA NEVADA, CALIFORNIA: Geol. Soc. America, Bull., v. 71, no. 4, p. 483-496, 4 illus., 2 maps (1 fold.), 2 fold. secs., Apr. 1960, 37 refs.

A large fault system, here named the Foothills fault system, is the dominant structural feature of the western Sierra Nevada. The steeply dipping to vertical component faults trend northwestward through an area about 200 mi. long and 30 mi. wide N. of 37°30'N. The faulted Paleozoic and Mesozoic rocks are overlapped by unfaulted younger rocks, and the toal extent of the fault system is not known. It is probably not limited to the western Sierra Nevada. Faults are marked by belts as much as 4 mi. wide, of cataclastically deformed and recrystallized rocks and by truncated folds. Along 1 fault, Upper Jurassic rocks are juxtaposed against Paleozoic rocks for at least 100 mi. The direction of fault movement has not been determined. Net displacement on some of the component faults exceeds 3,000 ft. and may be measurable in miles. Major faults cut beds of Late Jurassic age and are in turn cut by plutonic rocks of probable Late Jurassic and Middle Cretaceous age. Faults that controlled deposition of quartz veins and Au ore bodies of the Mother Lode belt are apparently younger and structurally less important features superimposed on one of the fault zones of the large system.--Auth.

2-1387. Allen, Clarence R., Leon T. Silver, and Francis G. Stehli. AGUA BLANCA FAULT - A MAJOR TRANSVERSE STRUCTURE OF NORTHERN BAJA CALIFORNIA, MEXICO: Geol. Soc. America, Bull., v. 71, no. 4, p. 457-482, 7 illus., 10 maps, table, Apr. 1960, 44 refs.

Agua Blanca fault is a major right-handed strike-slip fault at least 80 mi. in length that cuts transversely across the peninsula of Baja California about 70 mi. S. of the international border. Its trend is anomalous in being more nearly parallel to the Transverse Ranges of southern California than to the San Andreas fault system that elsewhere dominates the tectonic grain of the peninsula. Geographic features delineating the fault trace are, from E. to W: Paso San Matías, Valle de La Trinidad, Cañon de Dolores, Valle de Agua Blanca, Valle de Santo Tomás, Bahía Soledad (S. branch of fault), Punta Banda (N. branch). Farther W., both branches of the fault control submarine topography, and possibly the fault system is continuous with the NW.-trending San Clemente fault off the southern California coast.

Physiographic expression of the Agua Blanca fault is remarkably similar to that of the San Andreas. Typical features are Recent scarps, offset streams, shutterridges, fault sags and saddles, side-hill ridges, and fault-controlled valleys. Most of these features are particularly well exhibited in Valle de Agua Blanca, which is designated as the type locality.

Rocks cut by the fault are mainly Cretaceous plutonic rocks of the southern California batholith and Lower Cretaceous (Albian) metavolcanic rocks. Along the Pacific Coast, the fault cuts Upper Cretaceous (Maestrichtian) postbatholithic sedimentary rocks that are otherwise surprisingly little deformed as compared to rocks of similar age in most of

California.

Agua Blanca fault shows a history of right-lateral displacement throughout its length. Recent stream offsets occur from Valle de La Trinidad nearly to the Pacific Ocean; distinctive Quaternary (?) fan gravels in Valle de Agua Blanca are offset laterally 1 mi. from their most likely source area across the fault; in the same area, a fault slice of distinctive antiperthitic granodiorite is best explained by 7 mi. of lateral displacement, and a nearby slice of quartz diorite may indicate displacement as great as 14 mi. In general, evidence of both Recent activity and amount of total displacement appear to increase westward. The fault coincides in gross aspect with a broad E.-W. zone of seismic activity in a region elsewhere characterized by relative quiescence, but no large historical earthquakes can be positively correlated with this fault.

Despite its orientation athwart the regional tectonic grain, Agua Blanca fault does not appear to represent a deep-seated structural feature analogous to those of the Transverse Ranges. Instead, it is probably one of several paths by which the San Andreas fault tends to break around the "knot" caused by the great bend of the San Andreas in southern California.--Auth.

2-1388. King, Philip B. THE ANATOMY AND HABITAT OF LOW-ANGLE THRUST FAULTS: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 115-125, 1 secs., 1960, 39 refs.

Low-angle thrust faults, commonly called "overthrusts," are faults with reverse movement, which dip at low angles. Along them, great sheets of rock have moved over the rocks beneath for distances as much as many miles. How they were formed is poorly understood, but much has been learned in recent decades regarding details of their geometry and space relations. Two relatively simple examples, the Pine Mountain fault of the Appalachian region and the Johnnie-Wheeler Pass fault of the Cordilleran region, illustrate this geometry. Initial fractures of these faults, rather than having been regularly dipping shear planes, consisted of a succession of flats and pitches, formed, respectively, on incompetent and competent units of the stratified sequence. This and other characteristics of these examples may also apply to more complex low-angle thrust faults, which have had a more eventful history and have been more obscured by superposed structures. Low-angle thrust faults characterize mainly the miogeosynclinal realm, and in many places seem to have formed near the margins of sedimentary basins or along the boundaries between one sedimentary basin and another.--Auth.

2-1389. Gilluly, James. A FOLDED THRUST IN NEVADA - INFERENCES AS TO TIME RELATIONS BETWEEN FOLDING AND FAULTING: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 68-79, 9 maps, 1 secs., 2 diags., 1960, 15 refs.

A segment of the Roberts thrust, a fault of regional extent in central Nevada, is strongly overturned at the border of a window in the northern Shoshone Range. The several branch faults that spring from the main thrust at and near the axis of overturning are, in order of decreasing age, successively less warped. This sequence suggests that folding of the thrust was concurrent with its development. The map pattern resembles that of many other windows in large thrusts; it is suggested that "eyelid" windows (which are framed by 2 or more thrust surfaces) are generally formed by concurrent folding and thrusting. --Auth.

2-1390. Billings, Marland P. DIASTROPHISM AND MOUNTAIN BUILDING: Geol. Soc. America, Bull., v. 71, no. 4, p. 363-397, 34 figs., incl. maps, secs., diags., 3 tables, Apr. 1960, 154 refs.

For many years the terms orogeny and mountain building have been used so loosely that they no longer convey definite meanings. Because of this lack of precision, hypotheses of diastrophism are often based on false premises.

Folding and thrusting, often referred to as tectogenesis or orogeny, is best displayed by stratified rocks. Some geologists believe that folds and thrusts are due to vertical movements accompanied by lateral spreading, that the strata are stretched an amount commensurate with the intensity of the folding, and that the opposite sides of the sedimentary packet do not move toward each other. Most geologists, however, agree that during folding and thrusting the strata are shortened and that the 2 opposite sides of the sedimentary packet move toward each other by an amount commensurate with the intensity of the folding. But it is not clear to what extent the entire crust in the deformed belt is shortened. In one extreme view, the 2 opposite ends of the deformed belt do not move toward each other, and the folds and thrusts result from gravity sliding. At the other extreme, the entire crust is believed to be shortened to the same extent as the sedimentary strata.

An excellent example of broad vertical movements (epeirogenesis) that has never been sufficiently emphasized is in eastern North America, involving the Appalachians, Coastal Plain, and Continental Shelf. During the Mesozoic and Cenozoic the Fall-Line surface was depressed as much as 20,000 ft. beneath the Continental Shelf, whereas it was uplifted at least 8,000 ft. over the Appalachians. The northeastern two-thirds of the Appalachian-Ouachita belt has been going up since the Jurassic, whereas the southwestern third has been going down. Thus the present Appalachians are unrelated to the late Paleozoic folding. Certain metamorphic minerals - such as kyanite - or certain metamorphic assemblages - such as jadeite and quartz - form at confining pressures found only at depths of tens of miles, implying tremendous erosion wherever such minerals or assemblages are exposed.

Broad vertical movements, accompanied by high-angle faulting, are illustrated by the fault-block mountains of the Basin and Range province and by such features as the Rhine graben and the rift valleys of Africa.

Although the nature of the displacement along the San Andreas fault [California] has been known for more than 50 years, only in recent decades have other large strike-slip faults been recognized. But it is now the fad to assign all kinds of faults and even nonexistent faults to the strike-slip category. In recent years seismologists have emphasized the importance of strike-slip faults. The author suggests that in the Fairview Peak-Dixie Valley, Nevada, earthquakes there is evidence that strike-slip movements are invading an area previously characterized by Basin-Range structure. The geologic record indicates that large strike-slip faults have been distinctly subordinate to folding, broad vertical movements, and broad vertical movements accompanied by high-angle faulting

Possible displacement of the crust or the entire

earth relative to the axis of rotation has been emphasized in recent years. Continental drift, if it occurs, is one such type of movement. Slipping of the entire crust over the mantle is another. Much research has been accomplished in paleomagnetism in recent years, but the data are too scanty and conflicting to permit any definite conclusions.

Among the possible causes of diastrophism are 1) contraction of the earth, 2) convection currents, 3) formation of large pockets of magma, 4) sialic material leaking out of the mantle, 5) conversion of sial to mantle by change of low-pressure minerals to high-pressure minerals, or the reverse, and 6) serpentinization or deserpentinization of the upper part of the mantle.

Mountain building is merely one manifestation of vertical movements of the crust. In the past, mountain building has been erroneously considered by many to be primarily the result of folding and thrusting. Certainly many modern ranges are the result of vertical uplift unrelated to folding. Many such uplifts are accompanied by high-angle faulting to produce fault-block mountains. Blocks caught between strike-slip faults may be squeezed upward if the blocks move toward each other. Mountainous uplifts have also resulted from folding and thrusting. Conversely, in some folded belts erosion appears to have kept pace with the rise of the folds so that no mountains developed.--Auth.

2-1391. Knopf, Adolph. **ANALYSIS OF SOME RECENT GEOSYNCLINAL THEORY**: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 126-136, table, 1960, 40 refs.

"Geosyncline" was invented by Dana in 1873. It was defined as "a down-bending of the crust"; the context supplied the connotation that a mountain chain would eventually arise from sediments accumulated in such a down-bending. However, "geosyncline" has not yet been adequately defined.

Stille's 1940 classification of geosynclines was introduced into America by Kay in 1942. Stille's 2 principal classes are based upon capacity to be folded. Highly foldable geosynclines are orthogeosynclines, weakly foldable, parageosynclines. Orthogeosynclines include eugeosynclines and miogeosynclines, distinguished by position, time of folding, and magmatism. Eugeosynclines supposedly determine the sites of autochthonous palingenic bathylithic magma. However, bathyliths occur also in so-called miogeosynclines, which necessitates the auxiliary hypothesis that magmas can travel laterally from their eugeosynclinal place of origin to a miogeosynclinal environment. Recent absolute age determinations on bathyliths render this hypothesis untenable.

Lawson maintained that geosynclines do not collapse until they have accumulated a critical thickness - approximately 40,000 ft. Nevertheless, geosynclines have been shown to fail under loads of 10,000 ft. or less. The maximum thickness of accumulation appears to be 40,000 ft.; consequently this limit suggests that stratigraphic thicknesses estimated to exceed 40,000 ft. require reduction.

In 1944 Stille introduced the concept of "regeneration," meaning thereby restoration of the orthogeosynclinal state in ancient fold-belts. This idea has stimulated, among other things, active interest in the fate of ore deposits in regenerated orthogeosynclines. Critical evidence of the effects of regeneration on the dispersal of preexistent ores is given by the isotopic composition of leads in galenas formed during successive orogenies.--Auth.

2-1392. Longwell, Chester R. **POSSIBLE EXPLANATION OF DIVERSE STRUCTURAL PATTERNS IN SOUTHERN NEVADA**: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 192-203, 3 maps, 1960, 18 refs.

In southern Nevada a belt of folds and thrusts striking generally N. is transected by a NW.-trending fracture zone on which right-lateral movement has occurred. This movement was in progress while some of the thrusts and folds were active. A suggested explanation assumes that the 2 structural patterns reflect independent controls at different levels in the crust.--Auth.

2-1393. Webb, Philip K. **GEOLOGY OF THE CAVANAL SYNCLINE, LE FLORE COUNTY, OKLAHOMA**: Oklahoma Geol. Survey, Circ. 51, 65 p., 2 maps (col. geol. map in pocket), 1960, 61 refs.

The Cavanal syncline is expressed at the surface by Cavanal Mountain and the Potato Mountains. Exposed rocks are of the Savanna and Boggy formations, Krebs group, Des Moines series [Pennsylvanian]. The syncline is a broad downwarp cut by N.-S. faults.--Auth.

2-1394. Osmond, John C. **TECTONIC HISTORY OF THE BASIN AND RANGE PROVINCE IN UTAH AND NEVADA**: Mining Engineering, v. 12, no. 3, p. 251-265, 8 maps, 9 secs., profile, March 1960, 50 refs.

N.-trending discontinuous ranges consisting of tilted fault blocks with complicated internal structure are characteristic of the area from the Wasatch Range to the Sierra Nevada. Generalized maps and cross sections illustrate the structural evolution of the region.

Beginning in Cambrian time, the Cordilleran geosyncline occupied the western margin of North America. The geosyncline was divided lengthwise into 2 parallel parts by a tectonic zone which trended NNE. across Nevada from near Tonapah.

This zone separated shallow water carbonates on the E. from deeper water clastics and volcanics on the W. during the lower Paleozoic. The tectonic rose as an elongate welt in Mississippian time and expanded eastward and westward until, by lower Tertiary time, it included the former area of the geosyncline. Zones of subsidence flanking the welt migrated to E. and W. as it expanded.

Deformation occurred in various parts of the welt in each period since Devonian with greater intensity in Mississippian, Jurassic-Cretaceous (Nevadan), and Cretaceous-Tertiary (Laramide). Widespread intrusion of granitic stocks occurred in middle Cretaceous and middle Tertiary.

Toward the end of lower Tertiary the relief of the region had been reduced, and most of it was covered by a large volume of essentially horizontal volcanic extrusives. Following the extensive intrusion and extrusion, the crust of the welt adjusted to regional rise by movement along preexisting fractures, and the present ranges and valleys began to develop.

Movement along faults has continued since Miocene, and many of the valleys have been filled with over 5,000 ft. of tuffaceous clays and sands.--Auth.

2-1395. Lomashov, I.P. **ON THE RELIEF OF LIMESTONE FOUNDATION IN THE SUB-MOSCOW BASIN**: Akad. Nauk SSSR, Bull., Geol. Ser., in

ranslation, 1958, no. 3, p. 86-96, 9 maps, pub. 959, 6 refs.

The foundation of the Moscow basin consists of redominantly carbonate lower Carboniferous and Jpper Devonian rocks. The surface of the founda- ion has a general dip toward the center of the Mos- ow syncline of 1.5 to 2 m. per km. and is charac- erized by locally significant irregularities of tec- onic origin.--M. Russell.

-1396. Rezanov, I.A. TECTONIC MAP OF THE TURKMEN-KHORASSAN MOUNTAINS: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 3, p. 51-67, map, pub. 1959, 41 refs.

This paper describes the map which has been constructed by the separation of structural units which differ from each other in the time of formation of flexures and the time of upheavals which altered these flexures. The nonuniform character of folding movements is shown by the age of folding and morphology of the folded structures.--Auth.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

ee also: Geologic Maps 2-1345; Areal and Regional eology 2-1349; Geomorphology 2-1359; Structural eology 2-1395; Paleontology 2-1433, 2-1469, 2-1471; eophysics 2-1503.

-1397. FORMATION CORRELATOR OF THE NITED STATES: Oil & Gas Jour. v. 58, no. 17, upplement (fold. chart), Apr. 25, 1960.

A 22 in. x 24 in. table with small insert map of ne United States illustrating the major basins. The able gives the formations for the West Coast, Gulf Coast, Rocky Mountains, Midcontinent, and Eastern tates areas. The tabulation is by states within the reas. Producing formations are indicated.--N. treet.

-1398. Zhemchuzhnikov, Yu. A. SIMILARITIES ND DIFFERENCES BETWEEN FACIES, FACIES-YCLIC, AND FACIES-TECTONIC METHODS OF HE STUDY OF COAL MEASURES: Akad. Nauk SSR, Bull., Geol. Ser., in translation, 1958, no. , p. 1-7, pub. 1959, 18 refs.

Periodicity in sedimentation is a characteristic f coal beds. Both the facies-tectonic and the facies- yclic methods of analysing this feature agree in ecognizing facies and rhythms as factors and regard he latter as the result of oscillating motion against background of general subsidence. The pure facies nalysis ignores cyclic regularity as a factor. Wheth- r tectonic activity is a factor in such alternation of eds is not proven one way or the other, but clearly ycles or rhythms in sedimentation have been estab- ished.--M. Russell.

-1399. James, Harold L. PROBLEMS OF TRATIGRAPHY AND CORRELATION OF PRECAM- RIAN ROCKS WITH PARTICULAR REFERENCE O THE LAKE SUPERIOR REGION: Am. Jour. Sci., 258-A (Bradley Volume), p. 104-114, chart, sec., raph, 1960, 23 refs.

Two great advances in geologic knowledge - the radually accruing evidence of the immense duration Precambrian time, which is now believed to rep- esent about 8 times that of the Paleozoic, Mesozoic, nd Cenozoic combined, and development of the cies concept, with concomitant destruction of "layer ake" stratigraphy - have forced thorough reappraisal of stratigraphic correlations of Precambrian rocks. his reappraisal, which is being made by many stu- ents of the Precambrian, has thrown doubt on here- fore accepted correlations and has led to greater aution in regional syntheses. Most of the familiar me and time-stratigraphic terms have been virtually bandoned except in type areas, but despite this pparent retrogression, Precambrian stratigraphy probably is on a sounder basis than ever before.

Within individual areas, even areas of highly deformed and metamorphosed rocks, problems of stratigraphy and of correlation are being solved by detailed mapping and application of the physical criteria of correlation. In the Lake Superior region, for example, about 100 formations, plus named stratigraphic equivalents, can be placed in sequential position; these formations represent a probable time span of more than 2 billion years. District-to-district correlations are made on the basis of structural position, highly distinctive sequences and "carry-over" units, and bracketing by isotope age determinations on older and younger crystalline rocks. The resultant stratigraphic classifications and correlations cannot attain the refinement possible in fossiliferous strata, but they provide useful approximations for reconstruction of regional geologic history.--Auth.

2-1400. Sudovikov, N.G. NEW DATA ON THE GEOLOGY OF THE PRECAMBRIAN OF THE ALDAN: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 73-79, pub. 1959, 9 refs.

The main problems of Precambrian geology are examined in the light of data obtained from new investigations by the Laboratory of Precambrian Geology [Academy of Sciences, U.S.S.R.]. Some statements of A. A. Kadensky are critically analyzed as well as the scheme of succession of geological events which he proposes for the Aldan Precambrian.--Auth.

2-1401. Kindle, Cecil H., and Harry B. Whittington. SOME STRATIGRAPHIC PROBLEMS OF THE COW HEAD AREA IN WESTERN NEWFOUNDLAND: New York Acad. Sci., Trans., v. 22, no. 1, p. 7-18, illus., 2 maps, 4 tables, Nov. 1959, ref.

As a result of field work undertaken in 1955, the authors published a paper in 1958 on "Stratigraphy of the Cow Head Region, Western Newfoundland" (Geological Abstracts, v. 6, no. 2, p. 66, June 1958). This paper details the results of some of the work done since that time.

A Cambrian and Ordovician sequence of rocks in the Cow Head area contains within a normal sequence of limestone and shale a series of conglomerates having fossiliferous boulders. From a faunal study of the trilobite fauna, the stratigraphic sequence is currently being deciphered. The Cambrian faunas in the boulders range from the Bathyuriscus-Elrathina zone of the Middle Cambrian to the top of the Cambrian. A fault at Cormorant Head on the Port-au-Port Peninsula probably is not related in origin to the conglomerates in associated rocks.--M. Russell.

2-1402. Keller, B.M. SILURIAN DEPOSITS ON THE AK-KERME PENINSULA: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 1-8, 3 illus., map, pub. 1959, 3 refs.

English translation of GeoScience Abstracts 1-379.

2-1403. Nosow, Edmund. SOME DEVONIAN-SILURIAN STRATIGRAPHIC RELATIONSHIPS ON THE WEST FLANK OF THE CINCINNATI ARCH (In: McGrain, Preston, and Thomas J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Third Annual Meeting, June 5, 1959: Kentucky Geol. Survey, Ser. 10, Spec. Pub. 2, p. 67-81, 4 maps, 3 charts, 3 secs., log, 1959).

Recent [oil] activity in S.-central Kentucky has created a need for a simplified explanation of Silurian-Devonian relationships on the W. flank of the Cincinnati arch. A discussion of the formations involved, and suggested areas for additional shallow potential oil and gas reservoirs are presented.--Auth.

2-1404. Varentsov, I.M. ON THE DISTRIBUTION OF CLASTICS IN THE GOTLANDIAN AND DEVONIAN OF THE TUVA DOWNWARP: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 107-110, pub. 1959, 3 refs.

The Tuva depression formed during the Gotlandian (Silurian). The 3 stages of the period (Llandovarian, Wenlock and Ludlow) correspond to a transgressive cycle. The Llandoverian sand-conglomerate, from 200 to 2,000 m. thick, was formed from vulcanogenic siliceous rocks in a basin with an intensively depressed bottom. The sediments of the Wenlock stage were formed in a shallow sea, and adjacent land was of a flat, slightly peneplain character. During the Ludlow stage the Gotlandian sea was in regression, and the sub-aqual continental-lagoonal multicolored sandy-aleuritic sediments were formed. The Lower Devonian was characterized by increased volcanic activity, and the sediments mixing with pyroclastic materials formed graywackes. During the Eifelian stage, the deposited clastic rocks varied in different parts of the depression. In the central part, the clastogene rocks are similar to the Lower Devonian rocks. They are mostly represented by the tuffite quartz-graywacke and fieldschist-graywacke varieties. The volcanic activity at this stage diminished, and the lava covers are found only in the lower parts of this stage. The accumulation of large strata of red sandstone was accomplished in shallow-water lagoons. The terrigenous deposits of the Givetian stage were mainly composed of tuffite-arkosic varieties. Different types of schist formations are also found here. Thus a Gotlandian and Devonian terrigene complex fills the middle-upper Paleozoic synclinal Tuva depression, and, by studying the changes in the composition and structures of the rocks, we can build a picture of the development of the depression.--LC.

2-1405. Semikhatova, S.V. ON THE HISTORY OF THE RUSSIAN PLATFORM DURING THE TOURNAISIAN AND EARLY VISEAN: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 9-21, 3 tables, pub. 1959, 35 refs.

The facies and stratigraphic divisions of a lower Carboniferous formation which forms a narrow zone of thick sediments in the Tatar republic, the Kuybyshev area and Udmurtia are described. The author distinguishes a zone containing Productus sublaevis Kon. and sandstone formations containing spores which are older than those of the Stalinogorsk horizon. Paleontologic and geologic arguments are given for placing the boundary between the Tournaisian and Visean stages in the Volga-Ural region at the bottom of the zone containing Productus sublaevis.--Auth.

2-1406. Koperina, V.V. FACIES AND TYPES OF COAL ACCUMULATION IN THE DONETS COAL MEASURES: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 1, p. 8-17, pub. 1959, 20 refs.

A review of facies content of rocks in the Donets coal measures shows that facies changes through the section may be explained by the change in relationship between the rate of subsidence and the rate of sediment accumulation and not by oscillatory movements.

Two types of coal accumulation occurred in the Donets: 1) along a flat littoral zone, protected by sand bars; 2) in a delta area with a migratory river mouth.--Auth.

2-1407. Jordan, Louise. PERMIAN SALT BEDS IN LAVERNE GAS AREA, HARPER COUNTY, OKLAHOMA: Oklahoma Geology Notes, v. 20, no. 2, p. 23-28, 3 logs, Feb. 1960, 5 refs.

Gamma, neutron, caliper, and resistivity logs of the Cities Service Oil Company No. 1 Dunnaway "B" well reveal the presence of 3 intervals of Permian salt beds interbedded with shale at depths ranging from 475 to 2,490 ft. below the derrick floor. The shallowest section begins 60 ft. below the Blaine formation at 475 ft. and extends to 625 ft. The section below the Cimarron anhydrite, 1,236 to 1,476 ft., is approximately 50% salt. Ten salt strata, ranging in thickness from 5 to 20 ft., are interbedded with shale and anhydrite from 2,040 to 2,265 ft. in the upper part of the Wellington formation; 49 ft. of salt are present in the 90-ft. interval from 2,400 to 2,490 ft. in the lower part of the Wellington.--Auth.

2-1408. Nesterenko, L.P. ON THE METHOD OF CORRELATION OF THE LOWER PERMIAN SECTIONS OF THE DONBAS, ITS NORTHWESTERN MARGINS AND THE EASTERN PART OF THE DNIEPER-DONETS DEPRESSION: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 111-113, pub. 1959, 6 refs.

English translation of GeoScience Abstracts 1-382.

2-1409. Azarov, A.A. ON THE AGE OF COAL-BEARING DEPOSITIONS IN THE TRANS-BAIKAL: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 1, p. 56-57, pub. 1959, 3 refs.

The Transbaikal coal measures consist of both Jurassic and Cretaceous rocks. Flora-faunal lists are given.--M. Russell.

2-1410. Pettyjohn, Wayne A. THE DAKOTA CONTROVERSY: South Dakota Acad. Sci., Proc., v. 38 (South Dakota, State Univ., Bull., ser. 60, no. 2), p. 34-38, map, 1959, pub. 1960, 14 refs.

The name Dakota was applied at the type locality ear southeastern South Dakota to a sequence of andy strata of Early and Late(?) Cretaceous age. lowever, in the Black Hills region the name "Dako- a" has been applied to all or parts of an Early Cre- aceous threefold sequence (Lakota sandstone-Fuson hale-Fall River sandstone) that is lithologically imilar to the sequence at the type locality. The all River sandstone is overlain by the Skull Creek hale, above which a second sand-shale-sand se- uence of Early Cretaceous age (Newcastle-Mowry- Frontier") is present. In central South Dakota the ame "Dakota" has been applied to at least 2 of the ower 3 sandstones.--Auth.

-1411. Dane, Carle H. THE BOUNDARY BE- WEEN ROCKS OF CARLILE AND NIOBRARA AGE N SAN JUAN BASIN, NEW MEXICO AND COLORA- O: Am. Jour. Sci., v. 258-A (Bradley Volume), . 46-56, map, 2 secs., 1960, 23 refs.

In the northern part of the San Juan basin, New lexico and Colorado, an unconformity at the base f beds of Niobrara [Upper Cretaceous] age cuts out 00 to 400 ft. of beds of late Carlile age [Upper retaceous] that in the southern part of the basin are epresented by beds from the top of the Juana Lopez andstone member of Rankin at least up to the top of he Gallego sandstone member of the Gallup sand- tone. The Juana Lopez sandstone member of the arlile shale and the Tres Hermanos sandstone mem- er in the lower part of the Mancos shale are shallow - ater marine sandstones, the tops of which are early time equivalent over very extensive areas. he Gallego sandstone member of the Gallup sand- tone of the Mesaverde group may be similar to them. he stratigraphic relations suggest that in a belt 30 o 75 mi. wide between the northern and southern arts of the basin downflexing toward the S. occurred uring the time of deposition.--Auth.

-1412. Maslakova, N.I., and D.P. Naydin. ON ENOMANIAN DEPOSITIONS OF THE CRIMEAN OUNTAINS: Akad. Nauk SSSR, Bull., Geol. Ser., n translation, 1958, no. 3, p. 97-99, secs., pub. 959.

Clayey and sandy marls of Cenomanian (Creta- eous) age in the Crimean mountains are divided into distinct stages, the lower characterized by mass ccumulations of Rotalipora apenninica, and the upper ontaining R. reicheli and R. montsalvensis.--M. ussell.

-1413. Maslakova, N.I., and D.P. Naydin. ON HE SANTONIAN DEPOSITIONS IN SOUTH-WEST RIMEA: Akad. Nauk SSSR, Bull., Geol. Ser., in ranslation, 1958, no. 1, p. 57-58, pub. 1959, 5 refs.

Santonian (Upper Cretaceous) deposits in the akhchisaray area of SW. Crimea are 65 m. thick. icropaleontological data and the occurrence of arsupites testudinarius indicates their age to be antonian, Horizon 5.--M. Russell.

-1414. Finko, V.I., and E.D. Zaklinskaya. ON HE STRATIGRAPHY OF THE FRIABLE FORMA- IONS OF THE ZEYSKO-BUREINSKAYA DEPRES- ION: Akad. Nauk SSSR, Bull., Geol. Ser., in trans- tion, 1958, no. 2, p. 22-42, 7 figs. incl. maps, harts, secs., 3 tables, pub. 1959, 22 refs.

Previously existing stratigraphic breakdowns of the sequences of friable formations in the Zeysko-Bureinskaya depression are subjected to a critical examination. On the basis of geologic, lithologic, and paleobotanic data, a new stratigraphic plan for the friable Tsagayanskaya formations of the Zeysko-Bureinskaya depression is proposed. They are to be classified as the Tsagayanskaya series. The series, in turn, is divided into suites: the Vodorazdelnaya (Oligocene), the Kivdinskaya (Paleocene-Eocene), and the Tsagayanskaya (Upper Cretaceous).--Auth.

2-1415. Love, J. David. CENOZOIC SEDIMENTATION AND CRUSTAL MOVEMENT IN WYOMING: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 204-214, illus., map, table, 1960, 20 refs.

One of the thickest and most complete sequences of Cenozoic nonmarine sedimentary rocks in North America is in Wyoming. During the Laramide revolution, which, in this region, began in latest Cretaceous time and was essentially over by the close of Eocene time, some basins were downwarped 30,000 ft. or more and some mountains upwarped at least 14,000 ft. Most basins were filled before the beginning of Oligocene time, and most mountain ranges were then partially buried by Oligocene, Miocene, and Pliocene strata. Some thrust faulting occurred along the SW. flank of the Gros Ventre Mountains during early Pliocene time. The highest plain of aggradation is thought to have been developed in central and northwestern Wyoming during middle Pliocene time and in eastern Wyoming in late Pliocene or early Pleistocene time. The later history of Wyoming was one of regional uplift, normal faulting, warping, and regional degradation, with minor local deposition of Pleistocene sediments.--Auth.

2-1416. Hooper, Kenneth. THE MARINE TERTIARY ROCKS OF BINNERINGI AT THE NORTH END OF LAKE COWAN, WESTERN AUSTRALIA: Carleton Univ., Dept. Geology, Geol. Paper 59-3, 13 p., fold. map, 1959, 12 refs.

Scattered outcrops of Tertiary (presumed Eocene) marine fossiliferous rocks of calcareous and siliceous facies rest unconformably upon the Precambrian at the N. end of Lake Cowan, Western Australia. The fauna of lamellibranchs, gastropods, echinoids, bryozoans, sponge spicules, and foraminifers is poorly preserved. The rocks (of shallow-water type) are tentatively correlated with the Plantagenet beds of the S. coast of Western Australia and probably indicate the most northern extension of the Eocene marine transgression in this region.

The petrology and succession of the Precambrian rocks - sediment, metasediment, greenstone, granite, pegmatite, gabbro, dolerite, and acid porphyry - are briefly described.--Auth.

2-1417. Malhotra, Chamen L., and Edward R. Tegland. A NEW TERTIARY FORMATION IN HARDING COUNTY, SOUTH DAKOTA: South Dakota Acad. Sci., Proc., v. 38 (South Dakota, State Univ., Bull., ser. 60, no. 2), p. 263-274, illus., map, 1959, pub. 1960, 2 refs.

A fossil assemblage recently collected in the southern portion of the Slim Buttes of Harding County indicates that the stratigraphic unit formerly mapped as Chadron is actually Duchasnean (basal Oligocene) in age. The authors propose the name Slim Buttes formation for this unit.

The configuration of surface of deposition, type of sorting and bedding, lack of basal conglomerate, position of clay beds, and presence of conglomerate and channel fills at the top of the Slim Buttes formation indicate that the sediments of this unit were probably deposited in a lake. At least, during the latter part of the period of deposition, the general direction of stream flow was from the NW.

Study of heavy mineral assemblages indicate that the sediments were largely derived from igneous rocks, probably either from the northern Black Hills or the Big Horn mountains. Direction of stream flow within the Slim Buttes formation, plus differences between mineral assemblages in the Black Hills and in the Slim Buttes samples, indicates that the northern Black Hills were probably not the source of sediments.--Auth.

2-1418. Golubeva, L.V. A STRATIGRAPHIC SCHEME FOR THE QUATERNARY DEPOSITS OF THE NORTHWESTERN PART OF THE WEST SIBERIAN LOWLANDS AND ITS PALEOFLORISTIC BASIS: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 43-52, 2 diags., pub. 1959, 19 refs.

A paleophytologic basis for stratigraphic subdivision of the Quaternary deposits is presented to aid in determining the number of glaciations, and also for correlation of the different Quaternary stratigraphic units of the northern west Siberian lowlands.

Spore-pollen analyses in conjunction with determinations of the macroscopic vegetation remains (seeds and diatoms) show a regular change in the constitution of the vegetation and, consequently, may be used as the basis for a stratigraphic classification. The changes in vegetation point to a rhythmic oscillation in the climate. Starting from the time of maximum (Samarovian) glaciation, 4 cool periods alternated with warmer intervals.--Auth.

2-1419. Steece, Fred. V. PLEISTOCENE VOLCANIC ASH IN SOUTHEASTERN SOUTH DAKOTA: South Dakota Acad. Sci., Proc., v. 38 (South Dakota, State Univ., Bull., ser. 60, no. 2), p. 41-44, 2 illus., map, 1959, pub. 1960, 2 refs.

Volcanic ash or ashy silts have been collected from several localities in southeastern South Dakota, and are correlated with the Pearlette ash bed of Kansas. Criteria for identification are shard shape, color, presence of inclusions, and refractive index.

The Pearlette ash bed in Kansas lies in the Meade formation, and is late Kansan in age. In Nebraska the Pearlette ash is a member of the Sappa formation, also of late Kansan age. Because its stratigraphic position is known, the ash is an important late Kansan time marker to which other Pleistocene deposits may be related.--Auth.

2-1420. Mezhvilk, A.A. GEOLOGIC DEVELOPMENT HISTORY OF NORTH KHARA-ULAKH: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 3, p. 68-74, map, pub. 1959, 14 refs.

This paper attempts to review the geologic history of N. Kham-Ulakh in the light of new data obtained as the result of a geologic survey on the scale 1:200,000. These data lead to the following general conclusions:

1) The N. Khara Ulakh territory and the edge of the Siberian platform experienced 13 major marine transgressions during the Paleozoic, Mesozoic, and Cenozoic eras.

2) The character of the tectonic movements changed often. In early and middle Paleozoic time, predominantly undulatory movements of platform type occurred, which were followed by the accumulation of carbonate deposits. During late Paleozoic time, differential movements of large amplitude occurred. At that time, the upper Paleozoic flexure, filled with terrigenous deposits, was formed. During the Triassic, Jurassic, and Lower Cretaceous periods, N. Khara-Ulakh experienced mainly undulatory movements, which also affected the edge of the Siberian plateau.

3)After early Carboniferous time, the platform was replaced by the late Paleozoic geosyncline, the formation of which was accompanied by deep fractures.

4) During late Cretaceous time, due to plicative dislocations, the folding spread towards the W. at the expense of the platform.

5) The deposition of rocks in the early transgressive stages in the early Permian, early Triassic, early Jurassic and early Cretaceous periods is characterized not by coarse-grained beds, as is generally assumed, but by fine-grained, clay-bearing formations, which during the regressive phase were succeeded by coarse-grained formations.--Auth. concl.

2-1421. Fairbairn, H.W., Patrick M. Hurley, William H. Pinson, Jr., and R.F. Cormier. AGE OF THE GRANITIC ROCKS OF NOVA SCOTIA: Geol. Soc. America, Bull., v. 71, no. 4, p. 399-413, fold. map, 2 charts, diags., 3 graphs, 7 tables, Apr. 1960, 22 refs.

The ages of biotite, muscovite, and K feldspar in granitic rocks from 27 localities in Nova Scotia, as determined by A/K and Sr/Rb methods, fall in the range 300 to 400 million years. At 2 localities, where nearby intrusive contacts with upper Lower Devonian fossiliferous sedimentary rocks are established, the best estimate of the age of the intrusive rocks is 365 $\pm$ 20 m.y. Biotite and K feldspar in granite from Boisdale Hills (Cape Breton Island), associated with nearby Middle Cambrian sedimentary rocks, have an estimated age of 500 $\pm$ 20 m.y. A single age analysis of biotite in the metamorphosed Meguma series gives 340 m.y. Radiation-damage ratios for zircon at 9 localities where the age has been determined show 1 concordant result and 8 which are lower than the A/K and Sr/Rb ages by 16 to 33%.

The evidence of the mineral ages in the granitic rocks investigated thus far in Nova Scotia strongly suggests a protracted period of intrusion in the Devonian, with the upper Lower Devonian older than 365 m.y. Middle Cambrian is tentatively believed to be older than 500 m.y.

Holmes' B time scale, with Cambrian limits of 430 and 510 m.y. and Devonian limits of 255 and 313 m.y., would require an extension of 10-25% to meet the Nova Scotia data.--Auth.

2-1422. Kupsch, W.O. RADIOCARBON-DATED ORGANIC SEDIMENT NEAR HERBERT, SASKATCHEWAN: Am. Jour. Sci., v. 258, no. 4, p. 282-292, map, chart, 2 diags., Apr. 1960, 9 refs.

Organic sediments from a depth of 11 ft. near Herbert, Saskatchewan, contain willow wood which has been radiocarbon dated at 10,050 $\pm$ 300 years B.P. The sediments contain in addition to the wood a faunule of predominantly snails and ostracodes.

lant fragments are common and include a few spruce ones. Marl with abundant remains of algae (Chara) s locally present. Spores and pollen recovered from ne sediment provide an insight into the type of vege- ation at the Herbert site 10,000 years ago.

Fauna and flora indicate sedimentation in quiet ater of a pond or small lake in a spruce-pine park- land with a few northern, broadleaved trees such as birch, willows, and probably aspen. Such an environment exists today in the forest belt of Saskatchewan, 200 mi. to the N. of Herbert. The change from forest to grassland, which now prevails near Herbert, is indicated by pollen analyses of the sediments overlying the radiocarbon dated wood.--Auth.

5. PALEONTOLOGY

ee also: Areal and Reglonal Geology 2-1353; Geomor- hology 2-1366; Stratigraphy 2-1401, 2-1418; Geochem- istry 2-1526; Fuels 2-1597.

-1423. Beerbower, James R. SEARCH FOR THE AST, AN INTRODUCTION TO PALEONTOLOGY: 62 p., 227 figs., 29 tables, Englewood Cliffs, New ersey, Prentice-Hall, Inc., 1960, approx. 300 refs.

This book is an introduction to the principles, roblems, and conclusions of paleontology for the eologist, biologist, and prospective paleontologist. he initial chapter describes the nature of paleontol- gy and the methods of approach to paleontologic roblems. The following chapter introduces the rinciples of descriptive, developmental, and func- ional morphology as they apply to fossils. The next opic is the relation of form to classification, and his chapter includes a survey of the major animal roups. The species is then approached from the opulation viewpoint, and the genetics, morphology, nd ecology of species populations, both fossil and ecent, are discussed. The distribution of species s considered in terms of habitat, historical factors, nd interspecies relationships; the concepts devel- ped are applied to paleoecologic problems. Both echanisms and patterns of evolution are described nd discussed with reference to paleontologic inter- retation. The phylogenetic basis of classification s considered with examples of phylogenetic inter- retation. Correlation is related to evolutionary equence, to paleoecologic factors in distribution, nd to practical problems of guide fossils, fossil ones, and time-stratigraphic classification. Suc- eeding chapters deal with the major fossil groups nd their living relatives, including the vertebrates. he phylogeny (and its morphologic basis), adapta- ons, and paleoecology of each group is discussed. lorphology is illustrated and described in accompa- ying glossaries; a simple classification is provided a tabular form. The book concludes with a survey f human evolution and its place in the Cenozoic ammalian radiations.--Auth.

-1424. Simpson, George Gaylord. NOTES ON HE MEASUREMENT OF FAUNAL RESEMBLANCE: m. Jour. Sci., v. 258-A (Bradley Volume), p. 300- 11, 2 tables, 1960, 6 refs.

Of various measures of taxonomic resemblance, he percentage in the smaller of 2 faunal samples of ae number of taxa common to both is most useful. tends to eliminate the effects of discrepancy in ize between the 2 faunas or samples, and when that iscrepancy is a factor in the problem being studied he percentage of common taxa may be used. When unas closely similar taxonomically are compared, may be desirable to take into account differences the relative abundances of taxa in common. For at purpose, measures based on rank correlation e suggested, but no such measure seems fully atisfactory. Several other measures used in cur- ent literature are discussed.--Auth.

2-1425. Hutchinson, G.E. ON EVOLUTIONARY EURYHALINITY: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 98-103, 1960, 15 refs.

The Monera and many of the lower groups of Protista exhibit extreme evolutionary euryhalinity, and it is impossible to state whether the lowest groups of organisms are characteristically inhabitants of fresh or salt water. In the Metazoa, the capacity to invade fresh water from the ocean is very irregular and probably represents a statistically superdispersed system. Such a system could be explained formally by supposing that the various physiological preadaptations required to invade fresh waters are distributed with characteristic but different probabilities. Once the osmotic problems have been surmounted by an invader, the problem of salt uptake from very dilute solutions remains. It is probable that many animals of marine origin which are found associated with fresh-water species only in coastal localities have simply failed to develop really efficient salt uptake mechanisms, even though they are osmotically well adapted to fresh water. There is probably some correlation between small size and evolutionary capacity to change from one environment to the other. The evidence from the Caspian basin suggests that chemical adaptation is only one aspect of invasion into fresh water; it is suggested that the preexisting fresh-water fauna now constitutes the major barrier against invasions from the sea.--Auth.

2-1426. Nursall, J.R. THE ORIGIN OF THE METAZOA: Royal Soc. Canada, Trans., Sec. 5, Biol. Sci., v. 53, p. 1-5, 1959, 24 refs.

It may be assumed that at the time of the origin of life on earth 2 conditions existed: 1) a supply of organic matter was present as nutrient, formed probably by physico-chemical means from inorganic compounds, and 2) eobionts could utilize the nutrient by adsorption or absorption. Under such conditions it is probable that life need not have originated from one single primeval progenitor but could have evolved separately at many different times and in many different forms. This implies that several phyla had independent origins, and it does not follow that all phyla must ultimately be related.--M. Russell.

2-1427. Woodring, W.P. PALEOECOLOGIC DISSONANCE; ASTARTE AND NIPA IN THE EARLY EOCENE LONDON CLAY: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 418-419, 1960, 6 refs.

Astarte (a chiefly circumarctic and boreal marine pelecypod) and Nipa (an Indo-Malayan palm) lived in the same region during early Eocene time when the London clay was deposited, whereas now they are separated by a gap of several thousand kilometers. Such examples of paleoecologic dissonance are more common than indicated by paleoecologic

generalities concerning Teriary marine faunas.--Auth.

2-1428. Emerson, William K. RESULTS OF THE PURITAN-AMERICAN MUSEUM OF NATURAL HISTORY EXPEDITION TO WESTERN MEXICO. 11. PLEISTOCENE INVERTEBRATES FROM CERALVO ISLAND: Am. Mus. Nat. History, Am. Mus. Novitates, no. 1995, 6 p., fig., March 1960.

Pleistocene metazoan invertebrates are reported for the first time from Ceralvo Island, Baja California, Mexico. An assemblage totaling 34 species of megafossils, 32 mollusks, and 2 stony corals, was collected from a low emergent terrace on the southern end of the island. All the species are extant forms that live in this region of the Gulf of California at the present time.--Auth.

2-1429. Sutherland, Patrick K., and J.M. Cocke. A SOLITARY RUGOSE CORAL OF EXCEPTIONAL SIZE FROM THE MIDDLE PENNSYLVANIAN OF OKLAHOMA: Oklahoma Geology Notes, v. 20, no. 4, p. 78-82, 3 illus., Apr. 1960, 4 refs.

Specimens of the largest caniniid coral known from the Pennsylvanian of North America are Pseudozaphrentoides sp., collected from the upper Des Moinesian Oologah formation, in Rogers County, Oklahoma. They are up to 10 in. long and 3 in. in diameter.--M. Russell.

2-1430. Cronoble, William R. AN OCCURRENCE OF ULOCRINUS BUTTSI MILLER AND GURLEY IN OKLAHOMA: Oklahoma Geology Notes, v. 20, no. 4, p. 96-99, 3 illus., table, Apr. 1960, 5 refs.

An excellently preserved dorsal cup of Ulocrinus buttsi Miller and Gurley was recently discovered in the Hogshooter formation (Missourian [Late Pennsylvanian]) of Nowata County, Oklahoma. Few well-preserved specimens of this species have been found; none of the previous descriptions of this species have been complete. The new Oklahoma specimen is described in detail; 16 of the more important measurements are tabulated. A comparison of the new specimen with the holotype is included. One photographic plate illustrating the posterior, anterior, and dorsal views of the specimen is also included.--Auth.

2-1431. Chenoweth, Philip A. STARFISH IMPRESSIONS FROM THE HILLTOP SHALE: Oklahoma Geology Notes, v. 20, no. 2, p. 35-36, 2 illus., Feb. 1960, ref.

Heretofore only a single specimen of a starfish has been reported in Oklahoma, this being an unidentified form found near Barnsdall. Several small starfish impressions are described and figured from the Hilltop shale (Missourian [Late Pennsylvanian]). The fossils occur in thin silty sandstones near the upper part of the formation and are found in a quarry near Wewoka, Seminole County. The fossils occur both as shallow depressions and as slightly raised molds. All are small, averaging 14 mm. from tip to tip. None can be identified, but they appear to belong to the subclass Asteroidea. Conditions for starfish preservation, as outlined by Schuchert, appear to have been well satisfied during deposition of the Hilltop shale, and it is thought likely that further search will yield more readily identified specimens.--Auth.

2-1432. Gill, Edmund D., and Kenneth E. Caster. CARPOID ECHINODERMS FROM THE SILURIAN AND DEVONIAN OF AUSTRALIA: Bulls. Am. Paleontology, v. 41, no. 185, 71 p., 8 illus., 10 pls., map, 2 charts (1 fold.), diag., March 1960, 70 refs.

The Silurian and Devonian carpoid echinoderms described in this paper are the first representatives of the class to be recorded from Australia. A new genus and species of the Carpoidea Mitrata, Victoriacystis wilkinsi (Upper Silurian, Lower Silurian?, and Lower Devonian?) are diagnosed. The Carpoidea Soluta genus Rutroclypeus (type species R. junori Withers), formerly assigned to the Xiphosura, is reanalyzed and 2 new species, R. victoriae and R. withersi, (Lower Devonian all) described. The Rhenish Lower Devonian Dendrocystites globulus Dehm is provisionally referred to the genus Rutroclypeus, and definitely to the new family based thereon. A new classification of the Carpoidea is proposed: 2 new subclasses, Homostelea and Homoiostelea are defined, and 2 new superorders of the Homoiostelea, Stylophora and Astylophora, proposed. In the order Soluta, 2 new families, Iowacystidae and Rutroclypeidae are diagnosed and the new genus of the Dendrocystitidae, Heckericystis (type species Dendrocystites kuckersianus Hecker), from the Russian Ordovician, proposed. Certain new names required by the Rules of Zoological Nomenclature are introduced. The distribution of the Carpoidea is considered, and the significance of the Australian forms for paleogeography is assessed.--Auth.

2-1433. Huffman, George G., and John M. Starke, Jr. SPIRIFER GRIMESI FROM THE ST. JOE LIMESTONE NEAR TAHLEQUAH, OKLAHOMA: Oklahoma Geology Notes, v. 20, no. 3, p. 50-52, 2 illus., March 1960, 15 refs.

The pedicle valve of a specimen of Spirifer grimesi Hall, 120 mm. wide and 80 mm. long, from the Lower Mississippian St. Joe limestone is described. The stratigraphic relations and faunal content of the formation are reviewed.--M. Russell.

2-1434. Valentine, James W. HABITATS AND SOURCES OF PLEISTOCENE MOLLUSKS AT TORREY PINES PARK, CALIFORNIA: Ecology, v. 41, no. 1, p. 161-165, 2 figs., Jan. 1960, 11 refs.

A molluscan fauna of 74 forms is recorded from an upper Pleistocene marine terrace carved on rocks on which sandy beaches are developed today. A large rocky-shore molluscan element is present, but the northern forms so characteristic of that element were not found. A Recent thanatocoenose from a nearby sandy beach also contained rocky-shore forms, which seem to have come from the S. Perhaps the rocky-shore Pleistocene element was washed from the S. where warm surface waters may have piled up at a rocky headland (Soledad Mountain).--Auth.

2-1435. Ladd, Harry S. ORIGIN OF THE PACIFIC ISLAND MOLLUSCAN FAUNA: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 137-150, illus., 2 maps, 1960, 50 refs.

It has long been recognized that the marine mollusks of the Pacific islands are related to the fauna of Indonesia, there being few ties between the mollusks of the islands and those of western America. Indonesia has been regarded as the center of dis-

ersal of the "Indo-Pacific fauna," yet prevailing inds, currents, and even the major storm tracks end from the islands toward Indonesia and the W.

Until recently all of the islands of the Pacific basin ere thought to be geologically very young, but data btained from submarine mapping, dredging, and rilling now indicate that: 1) a shallow-water fauna, cluding mollusks, was present in the area as early s middle Cretaceous; 2) rich Tertiary molluscan unas (possibly richer than those of today) were idespread both inside and outside the Pacific basin roper; 3) many, if not all, of the hundreds of atolls at lie between Hawaii and Indonesia stood above the ea (some as high islands) at intervals during the ertiary; 4) some 50 guyots, now far beneath the ea, projected into shallow water as additional epping stones for the distribution of marine life, any of them in the broad gap SW. of Hawaii. These iscoveries suggest that the Pacific islands once rmed a giant archipelago and that the islands could ve been the home of many elements of the Indo- cific fauna. Faunal migration, favored by winds d currents, was toward Indonesia rather than from

With some islands or parts of islands projecting ove the sea at all times since the Cretaceous there uld be a reasonable explanation for the ancient cks of land shells and plants found in Hawaii and er volcanic islands. The newly discovered step- ng stones appear to be satisfactory replacements r the land bridges once called for by many biolo- sts.--Auth.

1436. Taylor, Dwight W. DISTRIBUTION OF IE FRESHWATER CLAM PISIDIUM ULTRAMON- ANUM; A ZOOGEOGRAPHIC INQUIRY: Am. Jour. i., v. 258-A (Bradley Volume), p. 325-334, illus., maps, 1960, 20 refs.

Pisidium ultramontanum Prime, a freshwater clam the Sphaeriidae, is a relict species found living ly in northeastern California and S.-central Oregon. locene and Pleistocene fossils, however, document s former occurrence in the Snake River drainage far E. as southeastern Idaho. Analysis of the stribution of other mollusks and fishes associated th P. ultramontanum reveals a common pattern, ich can be traced by faunal links from one drain- e basin to another. These links form a chain which ads from Walker Lake in western Nevada across gle Lake and the upper Pit River, California, to amath Lake, Oregon; thence across Fossil Lake d the Malheur basin, Oregon, to the Snake River; d through Gentile Valley and Bear Lake, Idaho, to ah Lake, Utah. All of the relict mollusks and hes of lakes in the northern Great Basin, Snake ver drainage, and Klamath River drainage are lated to this pattern of distribution. These lakes e therefore thought to have been connected, al- ough not necessarily all at once.--Auth.

1437. Yochelson, Ellis L., and J. Thomas Dutro, LATE PALEOZOIC GASTROPODA FROM RTHERN ALASKA: U.S. Geol. Survey, Prof. per 334-D, p. 111-147, 9 maps, 3 pls., 2 charts, g., table, 1960, 50 refs.

Late Paleozoic gastropods from northern Alaska cur in rocks of both Mississippian and Permian e; most of the fossils studied came from the Mis- sippian. Although the gastropods are of use for ting the rocks only in the broadest terms, locally y are useful in establishing informal faunal zona- tion. On the basis of predominant occurrence of certain gastropods, it is possible to distinguish rocks of Early Mississippian, Late Mississippian, and Permian age. Two divisions, based on the distribution of gastropods, are distinguished in the Upper Mississippian. One collection, consisting entirely of specimens of Glabrocingulum and Trepospira, may indicate the presence of rocks of Pennsylvanian age. Occurrence and distribution data are summarized in tabular form.

The gastropod faunule is composed primarily of euomphalaceans, platyceratacean, pleurotomaria- ceans, neritaceans, and bellerophontaceans, in that order of abundance. There is no indication that a distinct boreal fauna is represented. Many of the specimens are poorly preserved, though some well- preserved shells occur, particularly among the pleurotomariaceans.

Thirty-four species are recognized in the system- atic treatment; 9 of these are formally named as new species and one is referred to a previously described species. One new pleurotomariacean genus, Nodospira, is described. At least 2 other new genera may occur in the faunule, but specimens are too incomplete for adequate taxonomic description. The occurrence of 2 scaphopod specimens is reported.

Most of the fossils were collected from the Brooks Range during fieldwork in connection with geologic investigations of Naval Petroleum Reserve no. 4 and adjacent areas. Some earlier collections from northern Alaska were restudied.--Auth.

2-1438. Pierce, W. Dwight. FOSSIL ARTHRO- PODS OF CALIFORNIA. NO. 22. A PROGRESS RE- PORT ON THE NODULE STUDIES: Southern Cali- fornia Acad. Sci., Bull., v. 58, pt. 2, p. 72-78, 1959.

A preliminary report on the fossil findings from 17,203 nodules mostly collected in the Calico Mts., San Bernardino County, California; some from Mt. Pinos, Frazier Mts., Ventura County; 2 from Tehachapi Mts., Kern County; and from a hill at Lenwood, San Bernardino County. The insects are silicified, 3-dimensional, with evidence of instanta- neous kill and preservation. The nodules are num- bered, weighed, measured, and sketched before treatment, usually with 20% formic acid. When the digestion of the nodule has proceeded a week, the sludge is filtered, washed, transferred by brushes to alcohol, and examined under microscope. Speci- mens are lifted by brush into xylol and mounted on slides in balsam. The groups so far found and re- corded by Palmer, Snyder, and the author, as well as the groups yet to be reported on, include Mollusca, Lymnaeidae; Ostracoda; Anostraca; Araneida; Acarina; Chelonethida; Scorpionida; Myriapoda; Collembola; Odonata, dragonflies and damsel fly; Orthoptera; Plecoptera; Isoptera; Hemiptera, Lygaeidae, Miridae, Notonectidae, and Saldidae; Homoptera; Aphidoptera; Aleurodoptera; Thysanop- tera; Lepidoptera; Coleoptera, Dytiscidae, Staphylinidae, Cybocephalidae, Hydrophilidae; Hymenoptera, ants and wasp; Diptera, Heleidae, Tendipedidae; fish and fish eggs; bird feathers; mammal hairs; algae, mosses, and stems and leaf of higher plants. An average of 1.9% of all nodules have evidence of insects externally. The silicified insects occur throughout the nodules.--Auth.

2-1439. Frederickson, Edward A. NEW EVI- DENCE CONCERNING DALMANITES OKLAHOMAE:

Oklahoma Geology Notes, v. 20, no. 3, p. 53-54, 2 illus., March 1960, ref.

The species Dalmanites oklahomae Richardson, based on a specimen found in the collections of the Chicago Natural History Museum, and assumed to be from the Silurian of Oklahoma, is revised on the basis of conspecific specimens from the Devonian Haragan formation of Oklahoma and assigned to the genus Neoprobolium. The corrected name of the species is Neoprobolium oklahomae (Richardson), age: lower Helderbergian.--Auth.

2-1440. Pierce, W. Dwight. SILICIFIED EGGS OF VERTEBRATES FROM CALICO MTS. NODULES: Southern California Acad. Sci., Bull., v. 58, pt. 2, p. 79-83, 3 illus., 1959.

In digesting Miocene nodules from the Calico Mts., California, for fossil insects, using 20% formic acid, there have been recovered from 3 quarter sections along Mule Cañon Drive, 26 silicified eggs, lacking amnion and showing the embryo in various stages of development. From the same area, 2 fish skeletons have also been found in nodules. The eggs measured 0.67 to 1.11 mm. (average 0.908 mm.) in length, and 0.34 to 0.63 mm. (average 0.50 mm.) in width. The fish skeleton measures 32.7 mm. in length (not complete), with thickness 9.9 mm.--Auth.

2-1441. Vallentyne, J.R. ON FISH REMAINS IN LACUSTRINE SEDIMENTS: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 344-349, 3 tables, 1960, 5 refs.

The uppermost 15 cm. of the deep-water sediments of Little Round Lake, Ontario, contain an abundance of fish bones and scales mostly derived from Perca flavescens. The average numbers found per square meter of sediment surface were 16,000, 650, 400, and 205, for scales, vertebrae, arches (neural and hemal), and ribs, respectively. The deep-water sediments of 2 other lakes were devoid of fish remains. The number of scales found in the surface sediments of a fish hatchery pond was 6% of the number expected from fish that had died in the pond.--Auth.

2-1442. Dunkle, David H., and Stanley J. Olsen. DESCRIPTION OF A BERYCIFORM FISH FROM THE OLIGOCENE OF FLORIDA: Florida Geol. Survey, Spec. Pub. no. 2 (Contr. Florida Vertebrate Paleontology, Paper no. 3), 20 p., 4 pls., 1959.

Beryciform fishes (snappers and squirrel-fishes) were well established and of wide distribution around the world by upper Cretaceous times. Details of their origin and anatomy remain obscure due to the paucity of their remains in sediments in the western hemisphere. A specimen of Holocentrites ovalis from the Florida Marianna limestone, of Oligocene age, is described, figured, and compared with related forms.--S. J. Olsen.

2-1443. Brattstrom, Bayard H., and Ann Sturn. A NEW SPECIES OF FOSSIL TURTLE FROM THE PLIOCENE OF OREGON, WITH NOTES ON OTHER FOSSIL CLEMMYS FROM WESTERN NORTH AMERICA: Southern California Acad. Sci., Bull., v. 58, pt. 2, p. 65-71, illus., 4 maps, 1959, 7 refs.

New or noteworthy fossil pond turtles, genus Clemmys, from western North America are listed or described. This includes C. owyheensis, n. sp., from the Pliocene of Oregon and Pliocene (Los Angeles, Riverside, and Kern counties, California) and Pleistocene (Los Angeles, Kern, Santa Barbara, Shasta and Fresno counties, California, and White Bluffs, Washington) records of C. marmorata. C. hesperia Hay is shown to fall within the variation of C. marmorata. The phylogenetic and distributional relationship of the western U.S. species of Clemmys (marmorata, saxea, morrisiae, bockmani, and owyheensis) are cited.--B. H. Brattstrom.

2-1444. Etheridge, Richard. THE SLENDER GLASS LIZARD, OPHISAURUS ATTENUATUS, FROM THE PLEISTOCENE (ILLINOIAN GLACIAL) OF OKLAHOMA: Copeia, 1960, no. 1, p. 46-47, 6 refs.

A brief note on the presence of a single dentary of an unidentified species of Eumeces from the Cudahy fauna (Pleistocene, Kansan glacial) of southwestern Kansas, and a single vertebra of Ophisaurus from the Doby Springs local fauna (Pleistocene, Illinoian glacial) of northwestern Oklahoma. These 2 fossils represent only lizards obtained from glacial age faunas in this area.

The vertebra is discussed in detail and compared with Ophisaurus attenuatus, O. compressus, and O. ventralis. It is assigned to Ophisaurus attenuatus.

The 3 modern species of the glass lizard (Ophisaurus) are indicated as probably being differentiated at least by Illinoian glacial time, and comments are made concerning their fossil and Recent distribution.--J. J. Stephens.

2-1445. Harrell, Byron E. NOTES ON FOSSIL BIRDS FROM THE PLEISTOCENE OF KANSAS AND OKLAHOMA: South Dakota Acad. Sci., Proc., v. 38, (South Dakota, State Univ., Bull., ser. 60, no. 2), p. 103-106, 1959, pub. 1960, 7 refs.

Fragmentary fossil bird bones from several Pleistocene sites in Kansas and Oklahoma were collected in 1954 by Dr. Claude W. Hibbard. A number of species can be identified. Spatula clypeata and Fulica americana are recorded from the Dixon local fauna, which is probably late Nebraskan in age. Euphagus cyanocephalus is identified from the Sanders local fauna, probably late Aftonian. Mareca americana is reported from the probably Sangamon Nye Sink locality in Oklahoma.--Auth.

2-1446. Marcus, Leslie F. A CENSUS OF THE ABUNDANT LARGE PLEISTOCENE MAMMALS FROM RANCHO LA BREA: Los Angeles County Mus., Contr. Sci. no. 38, p. 1-11, 2 figs., May 1960, 9 refs.

Ten species represented by 18 or more individuals are listed according to their abundance in the 7 major Los Angeles County Museum pits. Abundance was determined by counts of the best represented skeletal element (left or right side) of each species in each pit. The proportional relationship of the separate species in each pit is statistically analyzed, using the χ^2 test for deviation from similar proportional faunal composition among the several pits. The results show that although the pits had nearly the same fauna, they differed significantly in relative numbers of some of the species. The carnivores contribute the major part to the deviation. To explain the census differences, the hypothesis is advanced that the pits were not all continuously active for the same period of time.--Auth.

-1447. Stewart, T.D. FORM OF THE PUBIC ONE IN NEANDERTHAL MAN: Science, v. 131, . 3411, p. 1437-1438, 3 illus., May 13, 1960, 7 efs.

Shanidar I and III from Iraq have the same pecul- ar form of pubis as Tabūn I from Palestine. These re the only such pubes known to exist. These facts uggest that Neanderthal man (Shanidar-Tabūn) and n early variety of modern man (Skhūl) coexisted uring Mousterian times in this part of the world.--uth.

-1448. Jepsen, Glenn L. A NEW JERSEY MAS- ODON: 2d ed., New Jersey State Mus., Bull. 6, 0 p., 7 illus., 2 maps, diag., Feb. 1960, 14 refs.

The details of the 1954 discovery and subsequent estoration of "Matilda," a female Mammut ameri- anus, from Pleistocene peat-bog deposits in Sussex ounty, New Jersey, are given against the back- round of a general review of what is known of mas- odons. The find is unusual in that, although all ne parts were recovered by means of dragline equip- nent in water, most of the hyoid bones were re- overed. The skeleton was assembled at the Amer- can Museum of Natural History and put on perma- ent display at the State Museum in Trenton.--M. ussell.

-1449. Matthew, W.D., and J.R. Macdonald. WO NEW SPECIES OF OXYDACTYLUS FROM THE IDDLE MIOCENE ROSEBUD FORMATION IN ESTERN SOUTH DAKOTA: Am. Mus. Nat. Histo- y, Am. Mus. Novitates, no. 2003, 7 p., 5 figs., larch 1960.

Oxydactylus exilis Matthew and O. lacota Matthew re described. These species were proposed by latthew in an unpublished manuscript and are pre- ented in this paper so that they might be properly ntered in the literature.--J. R. Macdonald.

-1450. Wood, Albert E. A NEW SCIURAVID ODENT OF THE GENUS PAUROMYS FROM THE OCENE OF WYOMING: Am. Mus. Nat. History, m. Mus. Novitates, no. 1978, 6 p., fig., Dec. 1959.

A new sciuravid rodent, Pauromys schaubi, from ne upper Bridger is described and compared with perditus from the lower Bridger. It is considered o be somewhat more primitive than the earlier form. auromys is retained in the Sciuravidae as a possible ricetid ancestor, instead of including it (as does chaub) in the Cricetidae. The only known genus hat could be ancestral is the lower Eocene paramyid licroparamys.--Auth.

-1451. Hoffmeister, William S. SODIUM HYPO- HLORITE, A NEW OXIDIZING AGENT FOR THE REPARATION OF MICROFOSSILS: Oklahoma Ge- logy Notes, v. 20, no. 2, p. 34-35, Feb. 1960.

The Heard method of breaking down anthracite oals for separating out acid-insoluble microfossils nvolves the use of a 5.25% solution of sodium hypo- hlorite (i. e. Clorox) as the oxidizing agent. It is uperior to Schulze's solution and the dry method h that it is cheap, fast, safe, gentle, breaks down nthracite coals as well as bituminous coals and arbonaceous shales, and it is a good bleaching gent.--M. Russell.

2-1452. Wilson, L.R., and R.W. Hedlund. TWO TECHNIQUES FOR STAINING HYSTRICHOSPHAERIDS: Oklahoma Geology Notes, v. 20, no. 4, p. 101-102, Apr. 1960.

Fossil hystrichosphaerids can be stained red with aqueous safranine in a solution of pH8 or higher when heated in a double boiler for several minutes. Green is obtained by placing the microfossils in glycerine jelly and then staining with malachite green powder and baking for several days at 40°C.--A. Nicholson.

2-1453. Todd, Ruth. RECENT LITERATURE ON THE FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 10, pt. 4, p. 137-140, Oct. 1959.

Eighty-two briefly annotated references are given, arranged alphabetically by author. References are world-wide and are mostly from the period 1958-1959.

2-1454. Todd, Ruth. RECENT LITERATURE ON THE FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 1, p. 42-45, Jan. 1960.

Sixty-one briefly annotated references are given, arranged alphabetically by author. References are world-wide and are mostly from the period 1958-1959.

2-1455. Todd, Ruth. RECENT LITERATURE ON THE FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 2, p. 69-72, Apr. 1960.

Seventy-four briefly annotated references are given, arranged alphabetically by author. References are world-wide and primarily for 1959.

2-1456. Thalmann, Hans E. FORAMINIFERAL HOMONYMS: Cushman Found. Foraminiferal Research, Contr., v. 10, pt. 4, no. 201, p. 127-129, Oct. 1959.

Forty-six homonyms are listed, with references.

2-1457. Thalmann, Hans E. NEW NAMES FOR FORAMINIFERAL HOMONYMS IV.: Cushman Found. Foraminiferal Research, Contr., v. 10, pt. 4, no. 202, p. 130-131, Oct. 1959.

Twelve new names of foraminiferal homonyms are proposed.

2-1458. Banner, F.T., and Walter H. Blow. SOME PRIMARY TYPES OF SPECIES BELONGING TO THE SUPERFAMILY GLOBIGERINACEAE: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 1, no. 204, p. 1-41, 8 pls., 2 charts, Jan. 1960, 88 refs.

An attempt is made to clarify the taxonomy of those species of the superfamily Globigerinaceae which possess primary types deposited in London and Paris. The lectotypes of the following species are described: Globigerina bilobata d'Orbigny, G. bulloides d'Orb., G. bulloides borealis Brady, G. conglobata d'Orb., G. cretacea d'Orb., G. cristata Heron-Allen and Earland, G. dutertrei d'Orb., G. eggeri Rhumbler, G. elongata d'Orb., G. helicina d'Orb., G. megastoma Earland, G. puncticulata

Deshayes, G. punctulata d'Orb., G. quadrilobata d'Orb., G. rotundata d'Orb., G. rubra d'Orb., G. sacculifera Brady, Pullenia obliquiloculata Parker and Jones, Pulvinulina menardii fimbriata Brady, P. menardii tumida Brady, P. scitula Brady, Rotalia limbata d'Orb., R. menardii Parker, Jones and Brady, R. nitida d'Orb., Sphaeroidina bulloides var. dehiscens Parker and Jones, and Truncatulina humilis Brady. Neotypes are proposed and described for Globigerina conglomerata Schwager, G. seminulina Schwager and Rotalina cultrata d'Orbigny. Descriptions of the morphology of the above species are emended, and their taxonomy, stratigraphy, and phylogeny are discussed. The remaining syntypes of Globigerina depressa d'Orbigny, Rosalina linneiana d'Orb. and Rotalina canariensis d'Orb. are discussed. The taxon "Rotalia menardii d'Orbigny" is shown to be unavailable. Globotruncana mariei is proposed as a new name for the homonym Globotruncana cretacea Cushman non Globotruncana cretacea (d'Orbigny).--Auth.

2-1459. Banner, F.T., and Walter H. Blow. SOME PRIMARY TYPES OF SPECIES BELONGING TO THE SUPERFAMILY GLOBIGERINACEAE - A FURTHER TAXONOMIC NOTE: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 2, no. 206, p. 53, Apr. 1960.

Corrections are given for the authorship of 5 taxa discussed in the paper entitled "Some Primary Types of Species Belonging to the Superfamily Globigerinaceae" (see above). The conclusions of the paper are not affected by these corrections.

2-1460. Cole, W. Storrs. REVISION OF HELICOSTEGINA, HELICOLEPIDINA AND LEPIDOCYCLINA (POLYLEPIDINA): Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 2, no. 208, p. 57-63, 4 pls., Apr. 1960, 27 refs.

The genera Helicostegina and Helicolepidina and the subgenus Polylepidina of the genus Lepidocyclina are reviewed. New illustrations are given of many of the species discussed. The species Helicostegina gyralis Barker and Grimsdale is a synonym of H. dimorpha Barker and Grimsdale. The species previously known as Helicolepidina polygyralis Barker, Helicolepidina paucispira Barker and Grimsdale, and Helicostegina soldadensis Grimsdale are combined and assigned to the genus Helicostegina under the name H. polygyralis (Barker). Two species are recognized in the genus Helicolepidina, H. spiralis Tobler from the upper middle Eocene and H. nortoni Vaughan from the upper Eocene. The genus Eulinderina Barker and Grimsdale is a synonym of Lepidocyclina (Polylepidina). A brief statement on the probable evolution of the lepidocyclines and these other genera based on this revision is presented.--Auth.

2-1461. Hanzawa, Shoshiro. THE FORAMINIFERAL SPECIES FABIANIA CASSIS (OPPENHEIM), IN JAPAN: Cushman Found. Foraminiferal Research, Contr., v. 10, pt. 4, no. 199, p. 119-122, pl., table, Oct. 1959, 22 refs.

Specimens referred to the European species, Fabiania cassis (Oppenheim), have been found in a basal conglomerate of Eocene age on Shikoku island, southwestern Japan. The various species of Fabiania are analyzed. All of the species are seemingly synonyms of Fabiania cassis which has a world-wide distribution in the tropical belt.--Auth.

2-1462. Hedley, R.H. NEW OBSERVATIONS ON PELOSPHAERA CORNUTA: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 2, no. 207, p. 54-56, 5 illus., Apr. 1960, 15 refs.

Apart from the test of Pelosphaera cornuta the animal itself is characterized by having a relatively thick organic wall which is modified at one part in the form of an oral region with a definite mouth. In many respects this region is remarkably similar to that known in Gromia oviformis.

When characters of the test alone are considered, the inclusion of P. cornuta in the family Astrorhizidae may appear to be justified, whereas, if characters of the protoplasmic body are taken into account a closer affinity to the Saccamminidae is indicated.--Auth.

2-1463. Hofker, Jan. THE TAXONOMIC POSITIONS OF THE GENERA BOLDIA VAN BELLEN, 1946, AND ANOMALINELLA CUSHMAN, 1927: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 2, no. 205, p. 47-52, 11 illus., Apr. 1960, 12 refs.

The type species of Boldia van Bellen, 1946, was originally designated as Rotalina lobata Terquem. The specimens from the Montian of Bunde, Holland, upon which van Bellen based his genus were wrongly identified by him. They are referable to Boldia madrugaenis Cushman and Bermúdez which should, therefore, be considered the type species of Boldia. A second species from the same Montian material, questionably called Rotalia obesa Terquem by van Bellen, is referable to Boldia cubensis Cushman and Bermúdez.

Anomalinella rostrata (Brady) differs from the Planulina group of Almaena, Kelyphistoma, Planulinella only in having embracing chambers on both sides. The so-called supplementary apertures near the margin, even in the last-formed chamber, are closed by porous plates, as is the case in all the other groups mentioned. Comparison with the type species of Planulina, P. ariminensis d'Orbigny, leads to the conclusion that the whole group is a very homogenous one and must be closely related to the type species of Planulina. A simple emendation of the genus Planulina enables us to place all these forms in that genus, thus greatly simplifying our system.--Auth.

2-1464. Hofker, Jan. THE GENERA EPONIDES, LACOSTEINA, NUTTALLIDES, PLANORBULINA, AND HALKYARDIA: Cushman Found. Foraminiferal Research, Contr., v. 10, pt. 4, no. 198, p. 111-118, 27 illus., Oct. 1959, 19 refs.

Restudy of the type species of Eponides and Alabamina shows that the 2 genera are synonymous. Lacosteina belongs to the dentate Foraminifera. The coiled portion shows the features of Conorboides, being usually trochoid with the axis of coiling forming an angle with the triserial portion. Since the toothplates are also typical of Conorboides, Lacosteina probably represents a wild-growing form of that genus; the relationship between the 2 forms is similar to that between Dyocibicides and Cibicides. The type species of Nuttallides is nearly identical with Eocene Asterigerina campanella of Europe which differs only specifically from the type species of Asterigerina. Nuttallides is, therefore, a synonym of Asterigerina. The type species of Planorbulina

hows the characteristics of Cymbaloporetta, and the tter must be placed in the synonymy of the former. he family Cymbaloporettidae must be incorporated the Planorbulinidae. The whole group is allied to iscopulvinulina. The type species of Halkyardia hows an umbilical structure which resembles that Ferayina, but not that of Cymbaloporetta. It may that Cymbalopora, Halkyardia, and Ferayina long to one group of the Foraminifera, and it is rtain that Cymbaloporetta with its allies belong to quite different one.--Auth.

1465. Herrick, Stephen M. SOME SMALL ORAMINIFERA FROM SHELL BLUFF, GEORGIA: ulls. Am. Paleontology, v. 41, no. 187, p. 113-0, 3 pls., map, May 1960, 2 refs.

Microfossiliferous material was collected from he uppermost part of the large oyster bed (Cooke's nit 6, 1943 description) exposed at Shell Bluff, urke County, Georgia, in Feb. 1955. From the aterial a total of 20 species was identified, 19 of hich are illustrated. No new species were found. he age of these fossils is considered to be no older an uppermost Eocene and possibly younger. This mous locality, together with the type locality of e McBean formation [Eocene], is described and own on the map.--Auth.

1466. Keach, John M. PRELIMINARY FORA-INIFERAL POPULATION COUNT IN UPPER NIO-RARA CHALK: South Dakota Acad. Sci., Proc., v. (South Dakota, State Univ., Bull., ser. 60, no. , p. 54-56, 1959, pub. 1960, 4 refs.

Three test samples of clean picked Foraminifera om 1 cc. of Niobrara [Upper Cretaceous] chalk, ch averaging 290 forms and weighing 0.7 mg., ere used to determine the presence of an estimated 14,797 foraminifers in a cubic centimeter.

Out of 2,417 specimens identified, the following genera are arranged in their order of decreasing rcentage: Globigerinella, Globigerina, Gumbelina, oxostoma, Globotruncana, Bulimina.

The fauna suggests an open sea, moderately deep ublittoral environment with a well oxygenated bot-m. The dominant forms are planktonic and were ccumulated by ocean currents in an environment milar to the foraminiferal oozes of the present eans.--F. V. Steece.

1467. Barnard, Tom. SOME ARENACEOUS ORAMINIFERA FROM THE LIAS OF ENGLAND: ushman Found. Foraminiferal Research, Contr., 10, pt. 4, no. 203, p. 132-136, 10 illus. on pl., ct. 1959, 23 refs.

A group of arenaceous Foraminifera is described om the Lias of England. Some species are re-orded for the first time from England. The genera mmodiscus, Jaculella, and Proteonina are dis-ussed.--Auth.

1468. Waller, Harry O., and William Polski. LANKTONIC FORAMINIFERA OF THE ASIATIC HELF: Cushman Found. Foraminiferal Research, ontr., v. 10, pt. 4, no. 200, p. 123-126, pl., map, graphs, Oct. 1959, 4 refs.

About 300 bottom samples from the Gulf of Tonkin to the Yellow Sea were examined for their content planktonic Foraminifera. Faunal groups were stablished and related to thermal ranges and latitude. verage surface-water temperatures higher than 20°C.-27°C. yield greater than 75% normal sized, unbroken tests, whereas average surface-water temperatures less than 20°C.-27°C. produce mostly small, easily broken tests.

The distributions of some species suggest a zonation with depth. Coiling direction of Globorotalia menardii and Globorotalia trigonula is left whereas Globigerina subcretacea and Pulleniatina obliquiloculata coil right.

Four temperature restricted faunas are established: warm water restricted, 19°C.-30°C.; warm water preferred, 6°C.-30°C.; transitional, 4°C.-30°C.; cold water, 4°C.-26°C.--Auth.

2-1469. Cole, W. Storrs, Ruth Todd, and Charles G. Johnson. CONFLICTING AGE DETERMINATIONS SUGGESTED BY FORAMINIFERA ON YAP, CAROLINE ISLANDS: Bulls. Am. Paleontology, v. 41, no. 186, p. 73-112, 3 pls., map, 3 tables, March 1960, 39 refs.

The Map formation of Yap contains a good fauna of smaller planktonic and larger Foraminifera. This association of 2 kinds of Foraminifera, found in 2 samples, is the first such association observed by which comparison is possible between known and widely distributed zones of both larger and smaller Foraminifera in the Pacific.

The larger Foraminifera indicate correlation with formations on Guam and Fiji that are dated as Tertiary f (Miocene), and that overlie rocks of Tertiary e (early Miocene) age. The planktonic Foraminifera indicate correlation with a formation on Saipan that was provisionally dated as Tertiary d (late Oligocene) and that unconformably underlies rocks of Tertiary e age.

The Map formation is a variable, irregularly bedded, coarse, and unsorted breccia and conglomerate with distorted lenses of finer material and channels filled with stratified sandstone. The conglomeratic nature of the Map formation makes reworking of the globigerinids seem a reasonable explanation of the conflicting age indicated by the 2 parts of the assemblage. However, that explanation is not wholly satisfactory, as no source for the older Foraminifera has yet been found on Yap. Local expansion of ranges of index species or changes of sequence of zones that seem to apply consistently elsewhere in the Pacific are not acceptable explanations.--Auth.

2-1470. Bé, Allan W.H. SOME OBSERVATIONS ON ARCTIC PLANKTONIC FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 2, no. 209, p. 64-68, 3 illus., table, Apr. 1960, 10 refs.

Globigerina pachyderma (Ehrenberg) is believed to be the only species of planktonic Foraminifera living in the present central Arctic Ocean. It is thin-shelled and possesses a large aperture in its early stages (identified as small specimens of Globigerina eggeri or G. bulloides by previous workers), which contrast with features attained in its mature stages. The typical form of G. pachyderma, living below approximately 200 m. depth, is attained by crystalline thickening of the test and the addition of a reduced final chamber.--Auth.

2-1471. Johnson, Curtis L. MICROFOSSILS OF THE GREGORY SHALE MEMBER OF THE PIERRE FORMATION: South Dakota Acad. Sci., Proc., v.

38 (South Dakota, State Univ., Bull., ser. 60, no. 2), p. 49-52, 1959, pub. 1960, 6 refs.

Preliminary investigation of the microfauna of the Gregory shale [Upper Cretaceous] has disclosed the presence of species representing 10 different families of Foraminifera and 1 family of Ostracoda. In addition, some radiolarians are present in the upper Gregory.

Most of the foraminiferal tests are calcareous, but a few arenaceous forms are present. The fossil fauna represents benthonic and pelagic forms.

Ecologically, the genera suggest relatively shallow, warm seas of normal marine to brackish salinity, perhaps slightly on the alkaline side as indicated by pH evidence.

The Gregory shale shows possible correlation with the Taylor marl of Texas (Campanian) on the basis of foraminiferal evidence.--Auth.

2-1472. Lohman, Kenneth E. THE UBIQUITOUS DIATOM - A BRIEF SURVEY OF THE PRESENT STATE OF KNOWLEDGE: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 180-191, table, 1960, 20 refs.

Diatoms have distinctive and highly diversified tests or shells, similar to but not identical with opal in composition, accounting for their preservation as fossils in many kinds of sedimentary rocks and their importance to the geologist. The problem of unequivocally assigning diatoms and related minute unicellular or noncellular organisms to either the plant or the animal kingdom is increasingly being met by referring them to the Protista, which may be considered either as a separate kingdom of organisms or a confession of ignorance.

The earliest known large assemblage of marine diatoms occurs in rocks of Late Cretaceous age in California; the earliest known assemblage of nonmarine ones occurs in middle Oligocene rocks in Colorado. They are widespread over the globe, living today in virtually all nontoxic waters, occupying a wide variety of habitats. This wide distribution is explained by the ease with which these minute organisms may be transported over great distances in viable condition by means of water, wind, and attachment to larger organisms. The preservation of diatoms in sedimentary rocks is governed largely by the pH of the solutions penetrating the sediment, as the solubility of the diatom silica increases rapidly with increasing pH above 5. Even under such conditions diatoms may be preserved in calcareous concretions formed before the advent of the alkaline solutions.

The percentage of extinct species in any assemblage of diatoms increases with age of the enclosing sediment at rates comparable with those of mollusks, making them useful indicators of geologic time. The species in any assemblage still represented in living assemblages form the basis for paleoecological interpretations. The fact that large and representative assemblages of diatoms can be obtained from very small samples is of equal importance in both lines of investigation. The small size of the diatoms and their resulting ease of transportation introduces problems of reworking and contamination. The former is often difficult to evaluate; the latter can be virtually eliminated by systematic care and cleanliness in the collection and preparation of the samples.--Auth.

2-1473. Beck, Charles B. CONNECTION BETWEEN ARCHAEOPTERIS AND CALLIXYLON: Science, v. 131, no. 3412, p. 1524-1525, May 20, 1960, 5 refs.

Characters of 2 Upper Devonian genera, Archaeopteris, often considered to be a fern, and Callixylon, classified with the gymnosperms, have been recognized in a single specimen.--Auth.

2-1474. Huffman, George G., and John M. Starke, Jr. A NEW FOSSIL PLANT LOCALITY IN THE SYLAMORE MEMBER, CHATTANOOGA FORMATION, NORTHEASTERN CHEROKEE COUNTY, OKLAHOMA: Oklahoma Geology Notes, v. 20, no. 4, p. 89-91, 2 illus., map, Apr. 1960.

A new fossil plant locality in the Mississippian Chattanooga formation contains the shallow molds of tree trunks, tentatively identified as Cordaites.--M. Russell.

2-1475. Scott, Richard A., Elso S. Barghoorn, and Estella B. Leopold. HOW OLD ARE THE ANGIOSPERMS?: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 284-299, 1960, 77 refs.

The currently known paleontological evidence bearing on the time and appearance of the angiosperms in the fossil record is examined. Special attention is directed to the very considerable body of data derived from palynological studies made during the past decade in various parts of the world. It is concluded that no bona fide angiosperm remains, either megafossil or microfossil, have yet been described from rocks older than Early Cretaceous sediments. Their record, however, is extraordinarily and increasingly well-documented in post-Early Cretaceous sediments from the major geographic areas of the earth. Considering the efficiency of the atmospheric and fluvial media of transport of plant microfossils, and the well known instances of long distance transport of microfossils, it seems highly implausible that a major, evolving unit of the earth's terrestrial flora could have greatly antedated the Cretaceous without detection. The morphological problems in identification of "early" angiosperms and difficulties in determining their first appearance are briefly considered.--Auth.

2-1476. Wolfe, Jack A., and Elso S. Barghoorn. GENERIC CHANGE IN TERTIARY FLORAS IN RELATION TO AGE: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 388-399, 2 diags., table, 1960, 41 refs.

The question of an orderly, systematic change in generic composition with age of Cenozoic floras is reevaluated on the basis of 48 well-documented floras from the western United States. These data reinforce the conclusion that there is an orderly, progressive increase in modernity of fossil angiospermous floras with decreasing age. The changing ratio of native to exotic genera in fossil floras, when compared to the modern distribution of these same genera, is of such consistency, as a function of geologic time, that generic analysis of temperate zone floras preserved either as megafossils or microfossils provides in itself a reliable adjunct in the determination of age. The age-generic change is viewed as a reflection of broad regional and essentially unidirectional climatic change from late Eocene to Pliocene. Data on the physiognomic characteristics of fossil leaves is correlated with the age of fossil floras and change in generic composition.--Auth.

2-1477. Kremp, G.O.W., H.T. Ames, and A.J. Kovar. CATALOG OF FOSSIL SPORES AND POLLEN. VOLUME 9. TRIASSIC AND JURASSIC SPORES AND POLLEN: 163 p., illus., University Park, Pennsylvania, Pennsylvania State University, College of Mineral Industries, Dept. of Geology, Palynological Laboratories, 1960, refs.

One hundred and fifty-six specific or varietal descriptions of Triassic and Jurassic types from Europe and North America are presented in Vol. 9.

Contents:

Daugherty, L.H., 1941. The Upper Triassic Flora of Arizona, p. 1-4, 4 new descriptions.

Kraüsel, R., and G. Leschik, 1955. Die Keuperflora von Neuewelt bei Basel, II. Die Iso- und Mikrosporen, p. 5-150, 146 new descriptions.

Erdtman, G., 1948. Did Dicotyledonous Plants Exist in Early Jurassic Time?, p. 151-152, 2 new descriptions.

Lantz, J., 1958. Étude des Spores et Pollens d'un Échantillon Purbeckien de L'Ile d'Oléron, p. 153-156, 4 new descriptions.

2-1478. Wilson, L.R. FLORINITES PELUCIDUS AND ENDOSPORITES ORNATUS, WITH OBSERVATIONS ON THEIR MORPHOLOGY: Oklahoma Geology Notes, v. 20, no. 2, p. 29-33, pl., Feb. 1960, 10 refs.

Thin sections of the Pennsylvanian fossil Cordaianthus shuleri from an Iowa coal ball contain spores which in the dissociated state are known as Florinites, a fossil spore genus. Outside the pollen sacs of the Cordaianthus sections are spores of Endosporites ornatus. The sections illustrate morphological differences in the 2 genera. The germinal surface of Florinites is in the distal polar hemisphere and that of Endosporites is in the proximal polar hemisphere. The bladder of Endosporites completely encloses the central body, while in Florinites the bladder is attached slightly above the equator in the distal polar hemisphere. The germinal area of the Endosporites is a double wall consisting of the spore body wall and the bladder wall, which are fused in most of the proximal hemisphere. The germinal area of Florinites is a single layer as the bladder does not extend much beyond the equator of the spore body in the distal polar hemisphere. Endosporites has been found to be related to the lycopods and Florinites to the Cordaitales.--Auth.

6. GEOPHYSICS

See also: Geologic Maps 2-1312, 2-1314 through 2-1343; General and Regional Geology 2-1353; Structural Geology 2-1383, 2-1384; Stratigraphy 2-1407; Geochemistry 2-1510, 2-1516; Mineral Deposits 2-1580.

2-1479. Burkard, Richard K. GEODESY FOR THE LAYMAN: 77 p., maps, diags., St. Louis, Missouri, U.S. Air Force, Aeronautical Chart and Information Center, Oct. 1959.

The use of intermediate and long range rockets and missiles requires that the distance and direction from launch site to target be accurately known. The science of geodesy can help to provide this information.

The basic principles of geodesy and geodetic surveying are presented in an elementary form. The formation of geodetic datums is introduced, and the necessity of connecting or joining datums is discussed. Methods used to connect independent geodetic systems to a single world reference system are discussed. Particular emphasis is placed on the U.S. Air Force role in developing a World Geodetic System.--Auth.

2-1480. Lum, Daniel. GRAVITY METERS (GRAVIMETERS) USED IN GEOPHYSICAL EXPLORATION: South Dakota Acad. Sci., Proc., v. 38 (South Dakota, State Univ., Bull., ser. 60, no. 2), p. 29-31, 1959, pub. 1960, ref.

The variation of the Earth's gravitational attraction at different locations was first observed by Jean Richer in 1672 with a pendulum-operated clock, and it was with pendulums that the first relative values of gravity were measured. Gravity meters were developed later and have been used intensively during the past 30 years for oil exploration. Because gravimeters can measure changes in gravity of less than 1 part in 1 million of the Earth's total gravity, their sensitivity creates many difficult instrumental problems, which are briefly discussed. However, gravimeters used in the more accurate geodetic work today have an even greater reading accuracy of 1 part in 1 billion of the Earth's total gravity, as a result of instrument research and development to meet even more exacting requirements in precision.--Auth.

2-1481. Whitworth, Virgil L., Edward F. Haye, and Thomas M. Lindholm. GRAVITY-PHOTOGEOLOGY METHOD BOOSTS ACCURACY, CUTS COSTS: World Oil, v. 150, no. 5, p. 99-100, 104, 3 ports., illus., 2 maps, Apr. 1960.

Gravity surveys can be greatly improved by combining with photogeology and surface geologic data, particularly where there is alluvial material present. Densities of masses closest to the meter affect the readings most critically. As an example, an anomaly supposedly favorable according to the meter was followed as customary with an expensive seismic survey, after which it was discovered that this anomaly was due to alluvium at less than 80 ft. instead of the reported 8,000 ft. Other significant surface features determinable by photo or surface geology will lead to much improvement in gravity mapping and interpretation.--K. M. Willson.

2-1482. Bancroft, A.M. GRAVITY ANOMALIES OVER A BURIED STEP: Jour. Geophys. Research, v. 65, no. 5, p. 1630-1631, May 1960.

The expression $\underline{d} = \frac{t}{\exp(t/d_o) - 1}$ is derived for the case of a semi-infinite step of depth $\underline{d}$ and thickness $\underline{t}$. As $\underline{t}$ decreases to very small values, $\underline{d}$ increases and tends to the value d_o. The maximum depth to the step is therefore d_o; the actual depth is likely to be considerably less than d_o for reasonable values of density. The advantage of the formula for a step is that in cases where it is applicable it gives a smaller value of d_o than either of the formulas of Bott and Smith, and the relation between actual depth and d_o is very easily applied.

The expressions for $\underline{d}$ and d_o were originally

derived for use in the interpretation of the Bouguer anomalies near Holleford, Ontario, where a circular depression in the Precambrian basement is thought to represent a meteor crater. The maximum depth and thickness of the material filling the depression (shown by the negative anomaly to be lighter than the rocks exposed at the surface) were estimated to be 300 ft. and 650-1,600 ft., respectively; subsequent drilling to 1,100 ft. failed to reach the undisturbed Precambrian.--D. B. Vitaliano (courtesy Geophysical Abstracts).

2-1483. Woollard, George P., Ned A. Ostenso, and Edward C. Thiel. GRAVITY ANOMALIES, CRUSTAL STRUCTURE, AND GEOLOGY IN ALASKA: Jour. Geophys. Research, v. 65, no. 3, p. 1021-1037, 7 figs. incl. 2 maps, secs., 4 tables, March 1960, 18 refs.

A regional Bouguer gravity anomaly map of Alaska is interpreted in terms of variations in crustal structure and local geology. The crustal results are compared with those determined from seismic measurements in 2 areas in Alaska and one in Alberta, Canada. These comparisons indicate the importance of including crustal composition in the derivation of crustal thickness from gravity values and suggest that regional isostatic anomalies are probably more indicative of abnormal crustal composition than of abnormal crustal thickness. In the Prince William Sound area of Alaska the seismic measurements show that the positive anomaly associated with the area is related to a thick crust having a high density rather than to a thin crust as might be deducted on the assumption of a normal crustal density. The inverse effect noted in the common association of negative anomalies with granitic intrusions appears to prevail in southern Alaska, where the seismic value of crustal thickness over the Coast Range batholith is less than that which would be deduced from the gravity anomaly values. Although the data are too sparse to permit any extended study of local geologic features, several areas of local gravity anomaly are defined. In general, these can be correlated with known geologic features such as sedimentary basins, granite on basic rock intrusions, and the configuration of the buried crystalline rock surface.--Auth.

2-1484. Thiel, Edward C., A.P. Crary, Richard A. Haubrich, Jr., and John C. Behrendt. GRAVIMETRIC DETERMINATION OF OCEAN TIDE, WEDDELL AND ROSS SEAS, ANTARCTICA: Jour. Geophys. Research, v. 65, no. 2, p. 629-636, 7 figs. incl. map, graphs, 2 tables, Feb. 1960, 5 refs.

The use of the gravity meter for measurement of ocean tides is illustrated by studies on the floating ice shelves of Antarctica. The observations are complicated by high-frequency oscillations of the ice, attributed to oceanographic influences. Factors involved in the reduction of the gravimetric data are analyzed. Amplitude and phase are computed for the more significant tidal components, and the energy spectra from 0.03 to 4 cycles per day are presented. The Weddell Sea tide has both diurnal and semidiurnal components. The Ross Sea tide is diurnal, with the solar component predominating. The tidal range is greater in the Weddell Sea than in the Ross Sea. Correlation of tidal currents with changes in surface elevation provides an estimate of the inward dimension of the Ross Ice Shelf.--Auth.

2-1485. Balsley, James R., and A.F. Buddington. MAGNETIC SUSCEPTIBILITY ANISOTROPY AND FABRIC OF SOME ADIRONDACK GRANITES AND ORTHOGNEISSES: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 6-20, map, diag., table, 1960, 4 refs.

The magnetic susceptibility anisotropy of about 150 specimens of granites and orthogneisses of the NW. Adirondack area has been determined. The maximum susceptibility of the orthogneisses is uniformly about parallel to the lineation, and the minimum susceptibility is characteristically about at right angles to the planar structure. A high ratio of maximum to intermediate magnetic susceptibility indicates a high intensity of linear structure. A high ratio of the mean of the maximum and intermediate to the minimum magnetic susceptibility indicates a high intensity of planar structure. Studies of magnetic susceptibility anisotropy have permitted the determination of lineation in many rocks where it could not be determined in the field and have afforded quantitative bases for correlations with broad geologic structures.--Auth.

2-1486. Kobets, N.V., and B.V. Komarov. SOME PROBLEMS OF METHODOLOGY IN PROSPECTING FOR PRIMARY DIAMOND DEPOSITS BY AERO METHODS: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 80-86, 4 illus., pub. 1959, 3 refs.

English translation of GeoScience Abstracts 1-434.

2-1487. Chaney, P.E., F.M. Mayes, Jack W. Jones, and John Bennett. DRILL STEM LOGGING TOOL (In: McGrain, Preston, and Thomas J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Third Annual Meeting, June 5, 1959: Kentucky Geol. Survey, Ser. 10, Spec. Pub. 2, p. 61-66, illus., logs, 1959) ref.

A new tool has been developed to permit electric logging of freshly drilled formations. The device consists of a self-contained recording mechanism which is pumped down the drill pipe whenever a log is desired. An electrode assembly projects out through one of the mud passages of a jet bit. Logs are recorded during the normal process of coming out of the hole, or the tool may be recovered on a wire line. A sample log obtained with this tool is presented for comparison with a conventional log of the same section.--Auth.

2-1488. Campbell, Orton E. WHY SEDIMENTARY STRUCTURES SHOW HIGH SELF-POTENTIALS: World Oil, v. 150, no. 5, p. 97-98, port., 3 maps, Apr. 1960, 5 refs.

Mineralized halos are often associated with geologic structures and/or oil and gas accumulations for which no satisfactory explanation of the origin has been offered. It is fact that electrical earth currents, operating by electrolysis with differences of self-potentials, are present which are capable of producing the anomalies. Geological structure has a natural electrical field with the highest potential at the top of the structure. Stratigraphic traps are special and unique problems. Petroleum anomalies originate perhaps by upward rising migratory hydrocarbons which do not necessarily come from the petroleum accumulations. Hydrostatic and thermal

rces may be the ones which carry the minerals, t self-potential gradients are forces which deter- ine the halo patterns.--K. M. Willson.

1489. Byerly, Perry. EARTHQUAKE MECHA- SMS: Science, v. 131, no. 3412, p. 1493-1496, us., 3 diags., May 20, 1960, 17 refs.

Theory going back to Stokes and Love indicates at a sudden force applied to a part of an infinite omogeneous elastic medium sends out waves of ngitudinal and transverse types. The directional haracter of at least the beginnings of these waves preserved at a distance. This character depends the nature of the force system applied at the ource. It is widely agreed that the energy released seismic waves was gradually stored as potential nergy of strain before the shock. The moot question just how this strain energy is transformed into e kinetic energy of wave motion.--Auth. summ.

1490. Aki, Keiiti. STUDY OF EARTHQUAKE ECHANISM BY A METHOD OF PHASE EQUALIZA- ON APPLIED TO RAYLEIGH AND LOVE WAVES: ur. Geophys. Research, v. 65, no. 2, p. 729-740, figs. incl. map, table, Feb. 1960, 15 refs.

Rayleigh waves and Love waves are used for the udy of the earthquake mechanism by the applica- n of a method of phase equalization. In this ethod, an impulse response is computed from own phase-velocity data and instrument character- tics and is cross-correlated with an actual record. comparative study of Love waves from Kern unty [California] aftershocks of 1952 and those m Nevada shocks of 1954 strongly supports the pothesis of a pair of couples rather than a single uple for the earthquake source. Source functions r 5 Kern County aftershocks are derived from the yleigh waves recorded at Weston and Palisades. was found that the sense of principal motion in the urce function is in agreement with the fault-plane lution obtained from the P-wave data. Mantle yleigh waves are found to be useful for this pur- se also.--Auth.

1491. Gutenberg, Beno. THE SHADOW OF THE RTH'S CORE: Jour. Geophys. Research, v. 65, . 3, p. 1013-1020, 4 figs., 3 tables, March 1960, refs.

There is very good agreement between the ob- rved decrease in amplitudes of longitudinal waves ffracted at the boundary of the earth's core and rresponding theoretical results. Especially, no pid decrease of amplitudes at the beginning of the adow zone is to be expected. Theory and observa- ns show that the amplitudes of diffracted short- riod P waves decrease faster with distance in the adow zone than those of longer waves. At epi- ntral distances of over 110°, short-period dif- acted P waves emerge gradually, and their begin- ng can rarely be ascertained. Corresponding long- riod waves arrive within the limits of error at e time calculated on the assumption of a straight- e travel-time curve.

Amplitudes of waves diffracted from a caustic crease rapidly with distance; this usually limits e range of their observation to roughly 10°. On e contrary, amplitudes of P waves diffracted at the re may be visible on records of a great earthquake distances of 103° to180°. Observations for dif- acted S waves cover a much smaller range of dis- tances, since S waves appear in a portion of seismo- grams which is disturbed by earlier motion. Other- wise, observations indicate similar behavior for diffracted P and S waves.--Auth.

2-1492. Shurbet, D.H. THE EFFECT OF THE GULF OF MEXICO ON RAYLEIGH WAVE DISPER- SION: Jour. Geophys. Research, v. 65, no. 4, p. 1251-1255, map, 3 graphs, 2 tables, Apr. 1960, 10 refs.

The dispersion of Rayleigh waves crossing the Gulf of Mexico was measured. It is shown that the observed dispersion can be accounted for by consider- ing the presence of unconsolidated sediments. The average sediment thickness required to account for the dispersion is 7 km.--Auth.

2-1493. Helburn, Nicholas. SOUTHWESTERN MONTANA EARTHQUAKE AND LANDSLIDE: Geog. Rev., v. 50, no. 1, p. 109-111, Jan. 1960.

On Aug. 17, 1959, a major earthquake shook southwestern Montana, eastern Idaho, and northwest- ern Wyoming; its focus is tentatively located at 44°30'N., depth 25 mi., intensity 7.8 on Richter scale. Three important geologic aspects of the earthquake are faults and associated scarps, the behavior of Hebgen Lake, and landslides. Hebgen fault and the Red Canyon fault were active. Al- though the Hebgen Lake dam was not raised, the capacity of the lake was increased, for reasons not yet determined. Local ground-water activity and geyser activity in Yellowstone Park were temporarily stimulated. The Madison Canyon landslide blocked the Madison River, thus requiring intensive engin- eering efforts to prevent a disastrous washout. The U. S. Forest Service has set aside the area as one of national scientific interest.--M. Russell.

2-1494. Hardy, Clyde T., and Grant I. Gaeth. FIELD INVESTIGATION OF UTAH EARTHQUAKE, MAY 23, 1953: Utah Acad. Sci., Arts, & Letters, Proc., v. 36, 1958-1959, p. 137-140, map, pub. 1959, ref.

An isoseismic map of the Utah earthquake of May 23, 1953, was constructed for the purpose of locating the center of the disturbance. The epicenter had previously been reported in a newspaper account as probably in the mountains E. of Lehi, Utah. Co- ordinates, based on this general location, were later listed in the annual earthquake summary of the U. S. Coast and Geodetic Survey. Interrogation of numerous persons, one week after the quake, showed the epicenter to be about 3 mi. W. of Lehi, Utah, near the northwestern corner of Utah Lake. The active fault is probably associated with hot springs at Saratoga Resort.--Auth.

2-1495. Hardy, Clyde T. FIELD INVESTIGATION OF UTAH EARTHQUAKE, FEBRUARY 4, 1955: Utah Acad. Sci., Arts, & Letters, Proc., v. 36, 1958- 1959, p. 141-143, map, pub. 1959, ref.

An isoseismic map of the Utah earthquake of Feb. 4, 1955, made by interrogating about 40 persons on the day after the quake, shows the epicenter to have been in the northwestern part of Salt Lake City.

The trend of the fault responsible for the earth- quake bears about N. 21°E. and may be projected northward to a point about 2,000 ft. S. of Becks Hot

Springs. The fault and hot springs are probably associated.--From auth. introd. & concl.

2-1496. Ambraseys, Nicholas N. THE SEISMIC SEA WAVE OF JULY 9, 1956, IN THE GREEK ARCHIPELAGO: Jour. Geophys. Research, v. 65, no. 4, p. 1257-1265, 3 maps, 2 graphs, 2 tables, Apr. 1960, 17 refs.

The earthquake of July 9, 1956 (magnitude 7 1/2, epicentral intensity VIII-IX MM), with epicenter at 36°54'N. 26°12'E., was followed by a severe seismic sea wave which originated near 36°49'N., 26°09'E. The wave was probably produced by a series of landslides on the steep banks of the submarine trench of Amorgos. The amplitude of the wave near its source was 100 ft., and the agitation of the sea within the central area lasted several days. A list of seismic sea waves in the Greek archipelago and adjacent seas is given in the appendix.--Auth.

2-1497. Kisslinger, Carl. SEISMOGRAMS ASSOCIATED WITH THE NEAR PASSAGE OF TORNADOES: Jour. Geophys. Research, v. 65, no. 2, p. 721-728, 6 figs. incl. map, Feb. 1960, 5 refs.

The principal features found on seismograms obtained on 3 occasions when a tornado passed near the station are described. Long periods, 50 sec. and greater, predominate, with periods of 30 sec. and less and bursts of very short period activity superimposed. The classical solution for a vertical load on an elastic half-space is applied, and the results indicate that elastic tilts due to the static loading effect of the tornado contribute substantially to the basic form of the record. The shorter periods are ascribed to the dynamic loading of the high winds on obstacles in the path. Part of the activity is not ground motion but is due to the buoyancy effect caused by the rapid pressure fluctuations.--Auth.

2-1498. Gilbert, Freeman, and Gordon J.F. MacDonald. FREE OSCILLATIONS OF THE EARTH. I. TOROIDAL OSCILLATIONS: Jour. Geophys. Research, v. 65, no. 2, p. 675-693, 13 figs., incl. diags., graphs, 8 tables, Feb. 1960, 32 refs.

The free periods of toroidal oscillations of the earth have been computed for 2 earth models. The lowest period for the Gutenberg model earth is 2,651 sec. and for the Jeffreys-Bullen model 2,732 sec. The surface amplitudes of the oscillations have been computed for 3 kinds of delta function stress sources - a unit force, a unit couple, and a unit torque - at depths of 600, 250, 100, and 30 km. The amplitudes decrease with increasing depth of the source. For a unit couple at 600 km. the maximum amplitude of the lowest period for the Gutenberg model is 1.59×10^{-25} cm., and for the Jeffreys-Bullen model it is 0.70×10^{-25} cm. By using the free periods of oscillation we have extended Love wave phase velocity dispersion curves to include long-period Love waves.

The method used to compute the periods and amplitudes of the free oscillations is an extension of the Thomson-Haskell matrix method used in plane layered media.

An example is presented to show the correspondence between the free oscillations and ray theory.--Auth.

2-1499. Band, William. STUDIES IN THE THEORY OF SHOCK PROPAGATION IN SOLIDS: Jour. Geophys. Research, v. 65, no. 2, p. 695-719, 9 figs. incl. graph, profiles, table, Feb. 1960, 18 refs.

In Pt. 1 a single-parameter visco-elastic model of a shear-yielding solid is defined for which a permanent-regime solution of the equations of motion exists for any finite compression. The 'profile' of this compression as a function of distance is obtained in the form of an integral which can be evaluated when the velocity of propagation is known as a function of final compression. It is assumed that the permanent-regime solution approximates actual shock waves and that the velocity of the permanent-regime profile equals the shock velocity. Observed shock speeds are used to compute shock profiles in a number of metals. The maximum slope of the profile for any one metal increases with increasing compression. The limiting value of the maximum slope as the volume is extrapolated to zero gives a numerical estimate of the viscosity parameter, and this has been done for Al, Pb, Sn, Zn, and Zr.

In Pt. 2 Zener's linear theory of anelasticity has been generalized to materials with cubic crystal structure. The theory of the propagation and attenuation of plane waves, both longitudinal and transverse, along a principal axis of the crystal is presented. The combined effects of relaxation mechanisms and thermal diffusion are included. The significance of the results for the theory of shock propagation are discussed, and several questions are raised for later discussion.

In Pt. 3 the general equations for propagation of steady-state compression profiles in shear-yielding, heat-conducting, anelastic solids are given. Methods of solution by successive approximation are developed for Hookean solids, with both adiabatic and isothermal (very steep) profiles, and for non-Hookean solids with shock profiles. The results of Pt. 1 are corrected to include the effects of thermal conductivity and anelasticity. Heating aftereffects of shocks are discussed, including the effects of irreversible heating due to viscous yielding, etc., and it is shown how the temperature of the solid after passage of a shock profile may be calculated.--Auth.

2-1500. Birch, Francis. THE VELOCITY OF COMPRESSIONAL WAVES IN ROCKS TO 10 KILOBARS, PART 1: Jour. Geophys. Research, v. 65, no. 4, p. 1083-1102, 5 figs., 6 tables, Apr. 1960, 52 refs.

The velocity of compressional waves has been determined by measurement of travel time of pulses in specimens of rock at pressures to 10 kilobars and room temperature. Most of the samples, mainly igneous and metamorphic rocks, furnished 3 specimens oriented at right angles to one another. The present paper gives experimental details, modal analyses, and numerical tables of velocity as function of direction of propagation, initial density, and pressure. Discussion of various aspects of the measurements is reserved for Pt. 2.--Auth.

2-1501. Rosenbaum, J.H. THE LONG-TIME RESPONSE OF A LAYERED ELASTIC MEDIUM TO EXPLOSIVE SOUND: Jour. Geophys. Research, v. 65, no. 5, p. 1577-1613, 31 figs., table, May 1960, 9 refs.

The long-time response of a layered elastic medium is considered for the particular case of a point-source explosion in a liquid layer lying above an infinitely deep liquid bottom. An asymptotic solution,

id for large values of the time variable, is ob-
hed; it expresses the response in terms of har-
nic vibrations of the liquid layer. Special empha-
is placed on those vibrations which correspond
waves with small angles of incidence and which,
tause of radiation into the bottom, decay ex-
hentially with time. However, the well-known
ded-wave phenomenon, first discussed by Pekeris
1948, is also included in the present formulation.
A detailed presentation is made of the method of
alysis. This method is applicable to more com-
cated problems of direct geophysical interest.
merical results are presented for some typical
amples, the behavior of the phase velocity for the
yer modes being of particular interest.--Auth.

1502. Lovan, T.E. SONIC LOGGING - A METH-
OF POROSITY DETERMINATION (In: McGrain,
eston, and Thomas J. Crawford, eds. Proceed-
s of the Technical Session, Kentucky Oil and Gas
sociation, Twenty-Third Annual Meeting, June 5,
59: Kentucky Geol. Survey, Ser. 10, Spec. Pub.
p. 51-60, 2 diags., 4 logs, table, 1959) 2 refs.

The Sonic log as a method of determining reser-
ir porosity was introduced in the Tri-State area
Jan. 1959. It has advantages over other logging
thods in that it can be used in rocks of varying
rosities and for carbonate reservoir rocks as well
sandstones. Some examples of this well-logging
thod are given.--Auth.

1503. Savit, Carl H. USE SEISMIC DATA TO
ND STRATIGRAPHIC TRAPS: Oil & Gas Jour. v.
no. 15, p. 182-184, port., 2 logs, Apr. 11,
60, 10 refs.

Stratigraphy has been only incidentally determi-
ble by the seismograph. Stratigraphic information
s to be found by distinguishing the different kinds
reflections from the different kinds of rocks.
is implies getting rid of noise without filters and
ntrolling amplitude while retaining contrasts.
chniques are available but a great deal of experi-
nt and evaluation must be done. A short resume
its content accompanies each reference.--N.
reet.

1504. MacFarlane, R.M., and R.K. Ault.
CLEAR LOGGING IN THE APPALACHIAN BASIN
: McGrain, Preston, and Thomas J. Crawford,
s. Proceedings of the Technical Session, Kentucky
and Gas Association, Twenty-Third Annual
eting, June 5, 1959: Kentucky Geol. Survey, Ser.
, Spec. Pub. 2, p. 13-27, 4 diags., 7 logs,
59).

Gamma ray-neutron logs are being used for
rosity determination under various bore hole con-
ions. The gamma ray log is used to correct the
utron response so that true porosity (effective)
n be determined.

The combination gamma ray-dual spaced neutron
gs have been successful in detecting gas-bearing
rmations in wet or dry cased and uncased bore
es. The dual spaced neutron log is also used in
ferentiating between liquid filled porosity and gas
ed porosity. This combination of logs does not
icate formations as gas bearing in the case where
asion of bore hole liquid is greater than the depth
investigation of the neutron device.--Auth.

1505. Ratcliffe, E.H. THE THERMAL CON-
CTIVITIES OF OCEAN SEDIMENTS: Jour. Geo-
phys. Research, v. 65, no. 5, p. 1535-1541, 6 figs., incl. illus., diags., graph, table, May 1960, 12 refs.

As a part of the measurement of heat flow through the ocean floor, the thermal conductivities of samples of sediment from the Pacific, Atlantic, and Mediterranean areas have been determined in the laboratory by a steady-state method. Average values over a wide range of water content are found to depend more on water content than on solid phase constituents, and conductivities can be read from a diagram if the amount of contained sea water or the wet density of the sediment is known. A graph is included, showing the conductivities of wet, granular materials other than ocean sediment.--Auth.

2-1506. Pakiser, Louis C., Frank Press, and Martin F. Kane. GEOPHYSICAL INVESTIGATION OF MONO BASIN, CALIFORNIA: Geol. Soc. America, Bull., v. 71, no. 4, p. 415-447, 2 maps (1 fold.), sec., 14 profiles, 3 seismograms, 2 tables, Apr. 1960, 27 refs.

Gravity and seismic studies in Mono basin, Mono County, completed during the summer of 1957, revealed a large, roughly triangular block that had subsided about 18,000 + 5,000 ft. and received an accumulation of about 300 + 100 cu. mi. of light clastic sediments and volcanic material of Cenozoic age. The seemingly near-vertical faults that bound this great block are displaced toward the center of the basin from the surrounding mountain masses, but in general they are parallel to well-defined Basin and Range trends.

The gravity minimum anomaly associated with the Mono basin structure has a residual gravity relief of about 50 mgals. and the lowest gravity readings (on Paoha Island) yield a complete Bouguer gravity value of about − 260 mgals. with respect to the International Ellipsoid. The computed depth of subsidence is based on a density of 2.3 gms/cm^3 for the basin fill and 2.7 gms/cm^3 for the basement rocks. Seismic-refraction profiles at several places in the basin demonstrate that the Cenozoic deposits are thick where the gravity is low and relatively thin where the gravity is higher. Along common seismic and gravity profiles steep seismic dips coincide with steep gravity gradients. Numerous seismic reflections are present within the basin fill. Anomalies on 4 aeromagnetic profiles are related in part to volcanic material within the Cenozoic section.

It is concluded that Mono basin may be a volcano-tectonic depression caused by subsidence along faults, following extrusion of magma from a magma chamber at depth. Volcanic rocks of Pliocene(?) and Pleistocene ages are exceptionally abundant in this area.--Auth.

2-1507. Press, Frank. CRUSTAL STRUCTURE IN THE CALIFORNIA-NEVADA REGION: Jour. Geophys. Research, v. 65, no. 3, p. 1039-1051, 9 figs. incl. map, graphs, 5 tables, March 1960, 15 refs.

A case is made for the combined use of 3 methods for the study of the earth's crust in a given region: seismic refractions, surface wave phase velocity, and gravity. Only by this approach can the fine details of crustal structure be revealed. The standard phase-velocity curves are revised to take into account recent refraction results in South Africa and the Gutenberg low-velocity zone of the upper mantle. Restrictions on the use of the phase-velocity method alone are discussed.

In the California-Nevada region seismic refractions reveal the following structure below the sedi-

ments: 23 km. of granitic rock with velocities of 6.11 km./sec. and 3.49 km./sec. for compressional and shear waves; 26 km. of gabbroic-ultramafic rock with a compressional velocity of 7.66 km./sec. underlain by a zone of ultramafic rock with a compressional velocity of 8.11 km./sec. When this structure is used in computing theoretical Rayleigh wave phase velocities and gravity anomaly, discrepancies are found with the observed values which can be resolved by reducing the mean shear velocity and the density in the crust. It is probable that this reduction is limited to the intermediate crustal layer, and several modifications consistent with all 3 exploration methods are discussed.--Auth.

7. GEOCHEMISTRY

See also: Areal and Regional Geology 2-1353; Igneous and Metamorphic Petrology 2-1545, 2-1546, 2-1555; Mineral Deposits 2-1581; Fuels 2-1598.

2-1508. Roy, Rustum. HIGH PRESSURE - A NEW CHEMICAL TOOL: Mineral Industries, v. 29, no. 5, p. 1, 4-6, 8, 4 illus., 9 diags., Feb. 1960.

Until recently, pressure as a variable has been neglected in most physical-chemical studies relevant to geochemistry. Lately, however, it has become possible to study chemical reactions at pressures up to 1.5 million p.s.i. This paper describes briefly the different devices used for geochemical studies at high pressures, with particular emphasis on the apparatus currently in use at Pennsylvania State University, namely: externally and internally heated cold seal test tube bombs and externally heated uniaxial pressure devices. Included in this paper are some results obtained from the use of these pressure devices in such areas as: 1) synthesis of minerals and new materials, 2) melting of silicate material under volatile pressure, 3) stability of mineral phases and assemblages and their importance in petrology, and 4) application of results of high-pressure studies to geophysical problems.--D. Hawkins.

2-1509. Barton, Paul B., Jr., and Philip M. Bethke. THERMODYNAMIC PROPERTIES OF SOME SYNTHETIC ZINC AND COPPER MINERALS: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 21-34, 7 diags., table, 1960, 10 refs.

Measurement of pH of a solution of known Zn^{++} or Cu^{++} concentration in equilibrium with the metal hydroxide or oxide allows the calculation of an apparent equilibrium constant ($K' = [M^{++}] \cdot a^2_{OH^-}$) which varies with composition of the solution. Extrapolation of K' values to infinite dilution permits estimation of a true equilibrium constant ($K = a_{M^{++}} \cdot a^2_{OH^-}$). This procedure is applied to the determination of the equilibrium constant for ZnO (zincite). $CuCl_2$ and $CuSO_4$ solutions precipitate the basic salts $Cu_4(OH)_6Cl_2$ (atacamite), and $Cu_4(OH)_6SO_4$ (brochantite) at concentrations greater than about $10^{-4.5}$ molar. Extrapolation to infinite dilution gives the equilibrium constants for these basic salts. At higher pH values reactions such as

$$Cu_4(OH)_6Cl_2 + 2OH^- \rightleftarrows 4CuO + 2Cl^- + 4H_2O \quad (1)$$

and

$$Cu_4(OH)_6SO_2 + 2OH^- \rightleftarrows 4CuO + SO_4^{--} + 4H_2O \quad (2)$$

take place and permit the estimation of K for CuO (tenorite). For zincite, $K = 10^{-17.0 \pm 0.1}$; for brochantite, $K = 10^{-68.6 \pm 0.4}$; for atacamite, $K = 10^{-69.4 \pm 0.4}$; and for tenorite, $K = 10^{-19.7 \pm 0.4}$. The variation of K with temperature (25° to 75°C.) permits the calculation of heat content for tenorite, brochantite, and atacamite, but for tenorite the more reliable heat of formation is obtained from the free energy data and the entropy measured by Hu and Johnston.

To the extent that the pH measurements represent the H ion activity the ratio $\frac{K}{K'}$ gives the activity coefficient of the metal ion at any particular ionic strength. The activity coefficients of Cl^- and SO_4^{--} are derived from $\frac{[Cl^-]^2}{a^2_{OH^-}} = K_1$ and $\frac{[SO_4^{--}]}{a^2_{OH^-}} = K_2$ obtained by pH measurement from reactions (1) and (2).

The occurrence of tenorite in an ore body indicates that the concentration of Cu^{++} in the solutions which are in equilibrium with the oxidized ore is less than about $10^{-4.5}$ molar.--Auth.

2-1510. Boyd, Francis R., and J. L. England. APPARATUS FOR PHASE-EQUILIBRIUM MEASUREMENTS AT PRESSURES UP TO 50 KILOBARS AND TEMPERATURES UP TO 1750°C.: Jour. Geophys. Research, v. 65, no. 2, p. 741-748, 6 figs. incl. diags., graphs, 2 tables, Feb. 1960, 7 refs.

Construction and calibration of apparatus utilizing a solid pressure medium for phase-equilibrium studies at elevated temperatures and pressures are described. Pressure calibration is carried out by measurement of the Bi I-Bi II and Tl II-Tl III transitions. A new determination of the Tl transition, 37.1 ± 1.3 kilobars, is given. Tests indicate that talc is superior to pyrophyllite and boron nitride as a solid pressure medium for high-temperature work.--Auth.

2-1511. Korzhinsky, D.S. THE NUMBER OF FACTORS OF STATE IN SYSTEMS (A REPLY TO I.V. ALEXANDROV): Geokhimiya [in translation], 1958, no. 5, p. 641-645, pub. 1959, 7 refs.

The main area of disagreement between Alexandrov and Korzhinsky is the function and importance of intensive and extensive parameters of thermodynamic systems, where intensive parameters refer to such variables as temperature, pressure, and concentration, and extensive parameters are those dependent on mass, such as volume, entropy, and masses of components.

Korzhinsky states that the Gibbs phase rule, which considers only intensive parameters, finds frequent use in his previous publications, especially those dealing with analyses of mineral parageneses. Under certain conditions, however, the Gibbs formulation is inadequate and must be supplemented by Korzhinsky's equation, $f_{in} + f_{ex} = k + 2$, where f_{in} and f_{ex} are the intensive and extensive factors of state, and k is the number of components in the system. An example of such a condition would be a closed system in which the masses of the "k" components are fixed.--F. Manheim.

2-1512. Schairer, J. F., and Hatten S. Yoder, Jr. THE NATURE OF RESIDUAL LIQUIDS FROM CRYSTALLIZATION, WITH DATA ON THE SYSTEM NEPHELINE-DIOPSIDE-SILICA: Am. Jour. Sci.,

258-A (Bradley Volume), p. 273-283, 4 diags., le, 1960, 22 refs.

The phase-equilibrium relations in the system heline-diopside-silica have been determined. The albite-diopside, although it is not binary, divides s system into 2 parts, a silica-rich portion with ca as one of the solid phases in completely crys- ized mixtures and a nepheline-rich portion with heline as one of the solid phases in the final crys- ization product. In the system nepheline- pside-silica the primary phases are diopside obably an aluminous diopside solid solution), com- x nepheline solid solutions, carnegieite solid utions, sodic plagioclases, forsterite, tridymite, cristobalite. The join jadeite-diopside is not que in this system at 1 atm. pressure, and jade- is not encountered as a solid phase.

The results support Bowen's contention that ough fractionation a magma is impoverished in early-crystallizing minerals (in this case diop- e) and yields residual liquids rich in the alkali minosilicates.

The nature of the albite-diopside join indicates no single anhydrous composition can yield a id which through fractionation produces both a ca-rich residue and a nepheline-rich residue. There is a reaction relation between olivine and pside. This reaction relation should be as im- tant in the alkali basalts as the olivine-hyper- ne reaction relation is in the tholeiitic basalts.-- h.

513. Skinner, Brian J., and Howard T. Evans, CRYSTAL CHEMISTRY OF β-SPODUMENE LID SOLUTIONS ON THE JOIN $Li_2O.Al_2O_3$-SiO_2: . Jour. Sci., v. 258-A (Bradley Volume), p. 312- , illus., 3 diags., 2 tables, 1960, 12 refs.

β-spodumene ($LiAlSi_2O_6$) is tetragonal, space up $P4_32_12$, a = 7.5332 + 0.0008 Å and c = 9.1540 + 008 Å. It is isostructural with keatite (SiO_2) and ms an extensive solid solution towards SiO_2 and $AlSiO_4$. β-spodumenes of various compositions e synthesized and their unit cell edges deter- ned.

On the assumption that β-spodumene is a "stuffed ca structure" based on the known keatite structure, bable locations of the introduced Li atoms are ablished from geometrical considerations. From change of unit cell volume with composition, it deduced that, up to the spodumene composition, atoms are inserted in cavities on the twofold axes; ond this composition, additional cations are in- ted in cavities in general positions in the struc- e. Channels extend throughout the structure con- ting these cavities, providing paths along which atoms can move under potential gradients. These nnels account for the cation-exchange properties β-spodumene.

Data are presented on the composition of co-exist- β-spodumene solid solution and β-eucryptite id solution at 1350°C. and 1 atm. and on the com- sition of β-spodumene solid solution coexisting h tridymite at 1350°C. and 1 atm.--Auth.

514. Pistorius, Carl W. F. T., and George C. nnedy. STABILITY RELATIONS OF GROSSULAR- E AND HYDROGROSSULARITE AT HIGH TEMPER- URES AND PRESSURES: Am. Jour. Sci., v. 258, 4, p. 247-257, 2 diags., 2 tables, Apr. 1960, refs.

The equilibrium relations between hydrogrossularite + quartz and anorthite + wollastonite + water have been determined to 15,500 bars and 810°C. by means of the "simple squeezer" high-pressure apparatus. There is a continuous solid-solution series from grossularite, $3CaO \cdot Al_2O_3 \cdot 3SiO_2$, through hydrogrossularite to hibschite, $3CaO \cdot Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$. The composition of hydrogrossularite, above 500°C. and in equilibrium with quartz, is determined almost entirely by temperature. Grossularite is stable above 780° and 15 kilobars H_2O pressure in the presence of quartz.--Auth.

2-1515. Yoder, Hatten S., Jr., and Charles E. Weir. HIGH-PRESSURE FORM OF ANALCITE AND FREE ENERGY CHANGE WITH PRESSURE OF ANALCITE REACTIONS: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 420-433, 3 diags., 3 tables, 1960, 38 refs.

The compressibility of 4 natural analcites has been obtained up to 10,000 atm. at 25°C. All specimens show abnormal compressibility $[(\partial\beta/\partial P)_T > 0]$ and one exhibits a reversible transition at about 8,400 atm. Abnormal increase of compressibility with pressure usually precedes a transition, and it is suggested that a similar transition lies at higher pressures than those investigated for the 3 remaining specimens.

The compressibility and density data were used with previously obtained data to compute the volume change and free energy change with pressure for the reactions 2 analcite $\rightleftarrows$ nepheline + albite + 2 water, analcite $\rightleftarrows$ jadeite + water, and analcite + quartz $\rightleftarrows$ albite + water. The volume change for these reactions proceeding to the right is negative for all pressures investigated at 25°C.

The analcite exhibiting the transition showed an increase in birefringence after compression, which is attributed either to strain induced by the volume discontinuity or to retention of a possible lower symmetry of the high-pressure form. Lower symmetry in a high-pressure form is not uncommon in previously investigated substances.--Auth.

2-1516. Dachille, Frank, and Rustum Roy. HIGH PRESSURE STUDIES OF THE SYSTEM Mg_2GeO_4-Mg_2SiO_4 WITH SPECIAL REFERENCE TO THE OLIVINE-SPINEL TRANSITION: Am. Jour. Sci., v. 258, no. 4, p. 225-246, 14 diags., 4 tables, Apr. 1960, 31 refs.

The system Mg_2GeO_4-Mg_2SiO_4 has been studied to the experimental limits of available hydrothermal and uniaxial high pressure apparatuses.

The inversion temperature for the Mg_2GeO_4(spinel)-Mg_2GeO_4(olivine) equilibrium is 810°C. at atmospheric pressure. The ΔV of the inversion is 3.5 c.c./mole; ΔH is 3,690 + 180 cal./mole. The inversion temperature is raised by 0.025°C./bar for the first 5,500 bars. Infrared absorption spectra, X-ray intensities, and molar refractivities clearly show that Mg_2GeO_4 is an inverse spinel.

Solid solution between Mg_2GeO_4 and Mg_2SiO_4 is complete in the olivine phase at temperatures above that of the inversion in Mg_2GeO_4. The maximum silicate content of the spinel solid solutions at lower temperatures increases steadily with pressure, from 10 mole % at 700 bars to 50 mole % at 60,000 bars at 542°C. Extrapolation places the spinel-olivine transition for Mg_2SiO_4 at 100,000 + 15,000 bars. The change in the lattice spacings of the spinel solid solutions of $Mg_2(Ge,Si)O_4$ shows that Mg_2SiO_4(spinel)

has a cell edge of 8.22A. Therefore the $_{\Delta}V$ for this transition is 2.0 c.c./mole. The pressure dependence of the transition in Mg_2SiO_4 is estimated by extrapolation at 0.013°C./bar.

Experiments show that substitution of Fe^{2+} for Mg^{2+} markedly increases the maximum silicate content of the spinel solid solution under corresponding p-t conditions.

The geophysical implication of these results is that an olivine-spinel transition in the mantle of the earth does appear to be a reasonable explanation of the seismic and density discontinuities starting at 400 km.--Auth

2-1517. Verma, R.K. ELASTICITY OF SOME HIGH-DENSITY CRYSTALS: Jour. Geophys, Research, v. 65, no. 2, p. 757-766, illus., diag., 10 tables, Feb. 1960, 22 refs.

The adiabatic elastic constants of 2 garnets (spessartite-almandite and almandite), spinel (synthetic), rutile (synthetic), and olivine are reported. The stiffness constants C_{pq} were determined from the velocities of acoustic wave propagation in crystals. The velocities of wave propagation were measured by McSkimin's method. A frequency range of 6 to 12 Mc/s was used.--Auth.

2-1518. Boyd, Francis R., and J.L. England. THE QUARTZ-COESITE TRANSITION: Jour. Geophys. Research, v. 65, no. 2, p. 749-756, illus., 2 graphs, 4 tables, Feb. 1960, 13 refs.

The quartz-coesite transition curve has been determined over the temperature range 700°to 1700°C. in the pressure range 20 to 40 kb. The equation for the curve is $\bar{P} = 19.5 + 0.0112\bar{T}$, where $\bar{P}$ is in kilobars and $\bar{T}$ is in degrees centigrade. The determination was made with an internally heated tungsten carbide pressure vessel utilizing talc for a pressure medium. The results of some runs on the quartz-coesite transition with an anvil apparatus are described. These data are in poor agreement with the determination cited above, and the difference is interpreted as an effect of pressure gradients in quartz-coesite runs in the anvil apparatus. Quartz could not invert to coesite in the earth at depths less than about 100 km., and it is therefore unlikely that coesite has formed in crustal rocks.--Auth.

2-1519. Gast, Paul W. LIMITATIONS ON THE COMPOSITION OF THE UPPER MANTLE: Jour. Geophys. Research, v. 65, no. 4, p. 1287-1297, 5 tables, Apr. 1960, 50 refs.

New determinations of the isotopic composition of Sr and of the concentration of K, Rb, Cs, Sr, and Ba in rocks and meteorites are given. The isotopic abundance of Sr^{87} in the upper mantle and the crust appears to be lower than that found for chondrites. Furthermore, for a chondritic earth model, the concentrations of K, Rb, and Cs in the earth's crust are anomalous when compared with those of U, Ba, and Sr. These 2 concurring arguments indicate that the upper mantle and crust of the earth do not contain K, Rb, Cs, U, Ba, and Sr in the proportions found in chondrites and that the alkali metals are depleted relative to U, Sr, and Ba. This depletion may be an indication of a nonchondritic earth composition; it may also result from an earth differentiation in which K, Rb, and Cs were concentrated or retained in the lower mantle.--Auth.

2-1520. Green, Jack. SOME ASPECTS OF EXTRA-TERRESTRIAL GEOCHEMISTRY: Geochem. Soc., Geochem. News, no. 21, p. 3-8, 7 illus., diag., 3 tables, Apr. 1960, 6 refs.

Defluidization of the mantle of the moon and associated volcanism may have produced the following results: 1) Extensive production of silicic extrusives including welded tuffs in non-mare areas and subsequent evolution of more mafic extrusives as mare 2) Formation of calderas in and along zones of collapse and at fracture intersections. 3) Formation of relatively thick volcanic dust in non-mare areas, and only thin spallation dust in mare areas. However local accumulation of relatively thick dust in mare areas is probable in view of post-mare development of craters in maria. 4) Appreciable concentration of compounds in eternally shadowed zones particularly of Cl, Br, S, B, I, and F, and to a lesser extent, C, As, Hg, Sb, Ar, and Pb in non-mare areas relative to the average terrestrial sedimentary rock. Most of these elements have high neutron capture cross-sections. 5) Concentration of these compounds as minerals formed in environments low or lacking in O and under partial vacuum. These minerals might correspond to the closed-tube sublimates obtained in determinative mineralogical techniques.--From auth. introd.

2-1521. Hoffman, J.H., and Alfred O. Nier. COSMIC-RAY-PRODUCED HELIUM IN THE KEEN MOUNTAIN AND CASAS GRANDES METEORITES: Jour. Geophys. Research, v. 65, no. 3, p. 1063-1068, 5 figs., 3 tables, March 1960, 10 refs.

The He^3 and He^4 distributions have been measured in the Fe meteorites Keen Mountain [Virginia] and Casas Grandes [Mexico]. In the former, a small meteorite (6.75 kg.), the He^3 and He^4 concentrations did not depend upon position. In the latter, a large meteorite (1,550 kg.), a 'depth effect' was observed and contours of constant He^3 and He^4 content could be drawn. An attempt is made to explain the results in terms of the model earlier presented in connection with similar work on the Grant meteorite.--Auth.

2-1522. Larsen, Esper S., 3d, and David Gottfried URANIUM AND THORIUM IN SELECTED SUITES OF IGNEOUS ROCKS: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 151-169, 16 diags., 3 tables, 1960, 22 refs.

The U and Th contents of 199 igneous rocks from a variety of petrographic provinces is here summarized. Data are given for the Mesozoic calc-alkalic batholiths of the western United States; volcanic and hypabyssal rocks of the tholeiitic magma type from Hawaii and Virginia; and effusive calc-alkalic, alkalic, and subsilicic-alkalic rocks from the western United States and Hawaii.

The batholithic rocks show an increase of both U and Th from gabbro to quartz-monzonite and granite. The more extreme differentiates, chiefly muscovite quartz monzonites, contain considerably less U and Th than the quartz monzonites and granites, although the Th/U ratios are nearly the same. The volcanic and hypabyssal rocks in general show a similar increase in both Th and U toward the more felsic members. The alkalic basalts of the Honolulu volcanic series show an anomalous decrease in U and Th toward the right on a variation diagram.

The Th/U ratios remain fairly constant from the mafic to the felsic members of each series here studied; each series also has a more or less charac

istic Th/U ratio, ranging from 2 1/2 to 5. The itter of Th contents, U contents, and Th/U ratios larger with increasing complexity of magmatic ferentiation. The batholithic rocks have the eatest scatter and have a significantly lower Th/U io in the gabbros than in the more felsic members. Our data show no increasing loss of U relative Th from the magma during the later stages of rystallization.--Auth.

1523. Skougstad, Marvin W., and C. Albert rr. OCCURRENCE OF STRONTIUM IN NATURAL ATER: U.S. Geol. Survey, Circ. 420, 6 p., map, ables, 1960, 8 refs.

The regions where the stable Sr content of surface ters is relatively low (less than 0.50 p.p.m.) inde the Pacific Northwest, northeastern United tes, and the central lowlands, particularly the ver Mississippi basin and the western Gulf Coast ea. Moderate concentrations of Sr (0.50 to 1.5 .m.) are found in streams of southeastern United tes, most of the Great Plains region, the western untain and plateau regions, and California. Relaely high concentrations of Sr occur in the surface ters of an area that includes northern and western xas and southern New Mexico and Arizona. Exptions to the above distribution are due to local logic conditions.--Auth.

1524. Garrels, Robert M., and M.E. Thompson. IDATION OF PYRITE BY IRON SULFATE SOLUONS: Am. Jour. Sci., v. 258-A (Bradley Volume), 57-67, 9 diags., 2 tables, 1960, 2 refs.

The rate of oxidation of pyrite specimens from 3 alities was measured in acid iron sulfate solutions. e rate of reduction of ferric ion in these solutions considered to be a measure of the rate of oxidation the pyrite. The over-all oxidation reaction, in the nge 100% to 0.1% $m_{Fe^{+++}}$ is in accord with the ssical reaction:

$$FeS_2 + 8H_2O + 14Fe^{+++} = 15Fe^{++} + 2SO_4^{--} + 16H^+.$$

The average rate of reduction from 100% $m_{Fe^{+++}}$ 50% $m_{Fe^{+++}}$ is constant for pyrite from a given ality, and differences in the average rates between ecimens from different localities could not be red to minor compositional variations of the solus or of the pyrites. The pH did not affect rate in tested range, pH 0 to pH 2.

The instantaneous rate of reduction of ferric ion minishes with decrease in the ferric-ferrous io; it is postulated that instantaneous rate is conlled by differential absorption of ferric and rous ions on the pyrite surface, and is proporinal to the fraction of pyrite surface occupied by ric ion.--Auth.

1525. Broecker, Wallace S. EXTENSION OF CHNIQUE FOR NATURAL TRITIUM MEASUREENTS: Columbia Univ., Lamont Geol. Observatory, nal Rept., Contract no. AF19(604)-4076, 25 p., us., 8 tables, Dec. 1959.

An attempt has been made to define the source and time variations in the natural background of large-volume proportional counters in order that more sensitive counters might be constructed for the tritium assay of natural waters. An 8-liter counter was constructed and tested with a number of different shielding arrangements, with different cathode materials, and with various filling gases. A description is given of the counter, including the main counter shell, 5 types of counter inserts tried, and counter shielding. A background of 22 c.p.m. is the minimum value obtained so far for methane at 1 atm. filling pressure. Hg and full water shielding are required to secure this low value; with increasing pressure, the background rises about 5 c.p.m. per atm. The dominant components of residual background are probably neutrons, gamma rays, and beta particles; alpha particles and mesons are of minor significance. Beta rays are as yet a question mark although they may be the most important contribution of all. Results obtained indicate the need for specific experiments which should permit a full analysis of background together with techniques for keeping it to a minimum.--M. Russell.

2-1526. Oana, Shinya, and Edward S. Deevey. CARBON 13 IN LAKE WATERS, AND ITS POSSIBLE BEARING ON PALEOLIMNOLOGY: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 253-272, diag., 7 tables, 1960, 38 refs.

Surface waters of dimictic lakes in Connecticut have an average δC^{13} of -8.6‰, but the hypolimnion is more depleted ($\delta C^{13} \geqslant$ -22.6‰). Seston, mud, and mollusc flesh average ca. -30‰, but submerged pondweeds are richer. Four sources, partly evaluable from C^{13} ratios, can contribute to hypolimnetic CO_2: a) surface CO_2 ($\delta C^{13} \sim$ -9‰), inherited from circulation; b) respiratory CO_2 ($\delta C^{13} \sim$ -30‰) from oxidation of seston; c) fermentation CO_2 ($\delta C^{13} \sim$ -5‰), here shown to be enriched at the expense of CH_4 ($\delta C^{13} \sim$ -70‰); d) carbonate CO_2 ($\delta C^{13} \sim$ 0‰), important in hard waters. Metabolism = b + c; and d, both heavy, can be separated by C^{14} assay, but this work is incomplete. In Quassapaug (softest), where d is negligible, c represents 4 to 20% of total metabolism. In Queechy (hardest), d could account for all heavy CO_2. In Linsley Pond (medium-hard), after allowance for d, c appears to provide 40% of total metabolism. Discovery that fermentation CO_2 is heavy raises important questions about groundwater. Applied to paleolimnology, C^{13} assay may be ambiguous for the same reason: fermentation tends to raise ratios lowered by aerobic metabolism. In one meromictic lake in a humid region, permanent stagnation has not produced fractionation, presumably because of c; owing to dominance of d, a meromictic saline lake also fails to show fractionation.

The earliest organic deposits of the last Pleistocene Searles Lake are enriched in C^{13}, presumably because the lake redissolved much carbonate, and the C^{13} ratio fell only gradually. In the middle Huronian Fe-banded cherts of Michigan, the $FeCO_3$-rich layers may be poorer in C^{13} than the SiO_2-rich layers, and the depletion of these siderites supports the lacustrine hypothesis.--Auth.

See also: Igneous and Metamorphic Petrology 2-1552, 2-1553; Sedimentary Petrology 2-1563; Mineral Deposits 2-1586.

2-1527. Silverman, E.N., and Thomas F. Bates. X-RAY DIFFRACTION STUDY OF ORIENTATION IN THE CHATTANOOGA SHALE: Am. Mineralogist, v. 45, no. 1/2, p. 60-68, 3 figs. incl. illus., diag., 2 tables, Jan.-Feb. 1960, 4 refs.

An X-ray diffraction technique has been used to obtain a quantitative measure of the degree of orientation of the (001) planes of 10 Å illite and mica flakes in 58 samples from a drill core taken from the Chattanooga shale. Thin sections cut perpendicular to the bedding are placed on the X-ray spectrometer in such a position that, upon rotation of the section in its own plane, the geiger counter records all diffraction from mica flakes with (001) perpendicular to the plane of the section. Analysis of the resulting curve, using the Chi-square statistic divided by the area under the curve, gives an "orientation index" for each specimen which is reproducible and independent of the amount of 10 Å material present.

An evaluation of the data with respect to the U content of the samples shows that there is no significant correlation between the concentration of the element and this particular measure of the texture of the rock. This supports other evidence which indicates that the U was precipitated during deposition of the sediment and that the distribution of U has not been affected by movement of solutions during or following compaction.

The technique is applicable to the study of lattice orientation of any sufficiently fine-grained mineral in natural or synthetic substances.--Auth.

2-1528. Clark, Joan R. X-RAY STUDY OF ALTERATION IN THE URANIUM MINERAL WYARTITE: Am. Mineralogist, v. 45, no. 1/2, p. 200-208, 2 illus., 4 tables, Jan.-Feb. 1960, 5 refs.

X-ray examinations of the mineral wyartite, assigned the chemical formula $UO_2 \cdot 6UO_3 \cdot 2CO_2 \cdot 3CaO \cdot 12\text{-}14H_2O$ by Guillemin and Protas, show that with passage of time the mineral is altering. Up to the present time 2 phases, both orthorhombic, have been found from repeated precession X-ray examination of a single crystal: wyartite I (comparable to "ianthinite" described by Bignand), $a = 11.25 \pm 0.03$, $b = 7.09_8 \pm 0.03$, $c = 20.80 \pm 0.06$ Å, space group $P2_12_12_1$-D^4_2 (no. 19), pseudo space-groups $P2_1cn$-C^9_{2v} (no. 33) or $Pmcn$-D^{16}_{2h} (no. 62); wyartite II (not previously described), $a = 11.25 \pm 0.03$, $b = 7.09_8 \pm 0.03$, $c = 16.83 \pm 0.05$ Å, space groups $P2_1cn$-C^9_{2v} (no. 33) or $Pmcn$-D^{16}_{2h} (no. 62), pseudo space-group $Pbcn$-D^{14}_{2h} (no. 60). Indexed X-ray powder diffraction data for both phases are given. The alteration occurs without visible external change in the crystals, so that interpretation of chemical analyses on macroscopic samples may be open to question. The precise nature of the alteration is still unknown, although oxidation of U^{+4} to U^{+6}, with formation of uranyl ions, possibly also accompanied by some dehydration, seems to be a plausible explanation.--Auth.

2-1529. McConnell, Duncan. THE CRYSTAL CHEMISTRY OF DAHLLITE: Am. Mineralogist, v. 45, no. 1/2, p. 209-216, illus., 3 tables, Jan.-Feb. 1960, 13 refs.

Chemical and powder diffraction data are given for fossilized dental enamel from a mastodon tooth. The specific gravity is 2.968 ($20^\circ/4^\circ$C.) and $a_o = 9.454$, $c_o = 6.892$ Å.

Calculations, analogous to those previously made for francolite, indicate that the carbonate groups enter the structure as substitutions for phosphate groups. However, (CO_3OH) does not appear to be an accurate representation. The recent supposition that carbonate groups can substitute for (F, OH) groups of normal apatite is untenable.--Auth.

2-1530. Gottardi, Glauco. THE CRYSTAL STRUCTURE OF PERRIERITE: Am. Mineralogist, v. 45, no. 1/2, p. 1-14, 3 figs., 7 tables, Jan.-Feb. 1960, 6 refs.

The crystal structure of perrierite (space group $C2/m$) has been determined by X-rays. The following chemical formula has been attributed to the mineral:

$$(Ce, La, Y, Th, Ca, Na)_4(Fe^{2+}, Ca)(Ti, Fe^{3+}, Fe^{2+}, Mg)_2Ti_2[O_4](Si, Al)_2O_7]_2$$

The unit cell contains 2 formula units.

Perrierite is a sorosilicate, with a high number of O-atoms not bonded to Si. In its structure there are 2 types of Ti-O octahedral chains along the b-axis; the chains are connected in order to give a sheet parallel to (001). Each Ce atom is surrounded by 10 oxygens; each Fe^{2+} by 6 oxygens. Interatomic distances are of the expected magnitude.--Auth.

2-1531. Brown, G.M. THE EFFECT OF ION SUBSTITUTION ON THE UNIT CELL DIMENSIONS OF THE COMMON CLINOPYROXENES: Am. Mineralogist, v. 45, no. 1/2, p. 15-38, 5 diags., 2 tables Jan.-Feb. 1960, 26 refs.

The unit-cell dimensions of 11 analyzed augites and ferroaugites from the Skaergaard intrusion [Greenland] are presented. The variation of the unit-cell dimensions b and $a \sin\beta$ is examined in relation to ion substitution, for the 23 analyzed common clinopyroxenes for which data are now available. For the 3 major substitution series, $Mg^{2+}:Fe^{2+}$, $Ca^{2+}:Fe^{2+}$ and $Ca^{2+}:Mg^{2+}$, the relationship between these 2 unit-cell dimensions and the ion substitution is regular, and linear equations are given for each series. The slope of the graph relating b-dimension to $Mg^{2+}:Fe^{2+}$ substitution is identical to that for the orthorhombic pyroxenes. The 3 series are combined in a triangular diagram relating unit-cell dimensions to $Ca^{2+}:Mg^{2+}:Fe^{2+}$ ratio, for the common clinopyroxene trapezium. The amount of substitution of Al^{3+} in octahedral coordination, and its effect on the b-cell dimension, is reconsidered.--Auth.

2-1532. Fleischer, Michael. STUDIES OF THE MANGANESE OXIDE MINERALS. III. PSILOMELANE: Am. Mineralogist, v. 45, no. 1/2, p. 176-187, 2 figs., 3 tables, Jan.-Feb. 1960, 23 refs.

Study of 14 analyses of psilomelane, including 7 new ones, verifies Wadsley's formula, $(Ba, H_2O)_4Mn_{10}O_{20}$. X-ray study of the products of dehydration shows that the water is lost zeolitically up to 500°C. and that the mineral is converted to hollandite at about 550°C. Thermogravimetric and differential thermal analysis curves are given for 2 analyzed samples.--Auth

2-1533. Smith, William Lee, Jerome Stone, Daphne R. Ross, and Harry Levine. DOVERITE,

POSSIBLE NEW YTTRIUM FLUOCARBONATE OM DOVER, MORRIS COUNTY, NEW JERSEY: . Mineralogist, v. 45, no. 1/2, p. 92-98, 4 les, Jan.-Feb. 1960, 5 refs.

Doverite, a possible new yttrium fluocarbonate, s found at the Scrub Oaks Fe mine at Dover. The neral occurs in brownish-red aggregates mixed h xenotime, hematite, and quartz. The aggregates irregular - some of them as large as 1 in. in meter - and most of them have rims of bastnae-e.

In parts of the mine, the doverite aggregate con-tutes several percent of the gangue. The aggre-e has indices of refraction in the range from 00 to 1.685. It is physically inseparable from the er components of the aggregate. Hematite and erite were leached from the aggregate leaving esidue of quartz and xenotime. From the X-ray der data, doverite is suggested to be an yttrian logue of synchisite and to have a general formula $CO_3 \cdot CaCO_3$, the Y in the formula including sever-elements of the rare-earth group.

The X-ray powder pattern of doverite bears a rked similarity to that of synchisite. The powder tern of synchisite was indexed in terms of a udo-orthorhombic C-centered cell with $a = 4.10$, 7.10, and $c = 9.12$ Å. From these data the cell nstants of doverite were calculated to be $a = 4.07$, 7.06, and $c = 9.12$ Å.

Inasmuch as doverite has not been satisfactorily ified from the aggregate, the possibility remains t doverite may be an Y-bearing synchisite. Until an be proven to be an end-member of a series, status as a new species is tentative.--Auth.

1534. Milton, Charles, and Joseph J. Fahey. ASSIFICATION AND ASSOCIATION OF THE CAR-NATE MINERALS OF THE GREEN RIVER FORMA-ON: Am. Jour. Sci., v. 258-A (Bradley Volume), 242-246, map, 3 diags., table, 1960, 15 refs.

About 1/4 of all known carbonate minerals occur the Green River formation of Wyoming, Utah, and lorado, a sequence of Eocene lacustrine deposits. st are alkali (Na) or alkali-earth (Ca, Mg, Ba) or ali-alkali earth carbonates; a few contain rare ths, or Al, Cl, or phosphate. Twenty well-defined ecies are listed, and arranged in accordance with na's system, 7th ed. The particular assemblage nd in each of the 3 states implies corresponding iation in the over-all geochemical and geological nditions affecting their deposition.--Auth.

1535. Leo, G.W. AUTUNITE FROM MT. POKANE, WASHINGTON: Am. Mineralogist, v. , no. 1/2, p. 99-128, 3 illus., map, 5 diags., graphs, 10 tables, Jan.-Feb. 1960, 36 refs.

Near Mt. Spokane, Washington, coarsely crystal-ne autunite is developed in vugs, fractures, and ear zones in granitic rock. With the exception of spersed submicroscopic uraninite particles, autun-e is the only ore mineral in the deposits. A study associated granitic rocks reveals that apatite, e most abundant accessory constituent, has been referentially leached and corroded in mineralized nes, suggesting that it may have provided a urce of lime and phosphate for the formation of tunite. Leaching may have been effected partly meteoric water, but more probably was due to the tion of ascending connate solutions that may also ve carried U from unoxidized, as yet undiscovered posits at depth.

Autunite from the Daybreak mine has been studied optically, chemically, and by X-ray diffraction. The autunite is commonly zoned from light-yellow margins to dark-green or black cores, and autunite from the inner zone has a higher specific gravity and higher refractive indices than peripheral light material. X-ray powder diffraction patterns of dark and light meta-autunite formed from this autunite show no significant differences in the d spacings; however, diffraction patterns of 9 zoned samples each show uraninite to be present in the dark, and absent from the light, phase. UO_2 and UO_3 determinations range from 0.66-0.70% and 57.9-58.0%, respectively, for light autunite, whereas dark autunite shows a range (in 7 determinations) of UO_2 from 1.2 to 4.0%, and UO_3 from 55.1 to 58.8%. The wide range of UO_2 values in dark autunite is tentatively attributed to nonuniform distribution of discrete uraninite particles, which may also account for the dark color and higher density.

Thermogravimetric and differential thermal analyses of autunite suggest discrete water losses at about 90°, 145°, and 220°C. The first water loss probably represents dehydration to meta-autunite II, also recognizable by marked changes in optical properties and the X-ray diffraction pattern. The form of the DTA curve above 90°C. resembles that of montmorillonite, suggesting that the dehydrations at about 145°C. and 220°C. may involve interlayer water as in montmorillonites, and the analogy with montmorillonite is further indicated by X-ray patterns of meta-autunite II heated just above these temperatures. Autunite heated to red heat shows a diffraction pattern distinct from all others. The cation exchange capacity of autunite, about 2.5 meq. per 100 g., is substantially lower than that previously reported for artificial material.--Auth.

2-1536. Milton, Charles, Edward C.T. Chao, Joseph M. Axelrod, and Frank S. Grimaldi. REEDMERGNERITE, $NaBSi_3O_8$, THE BORON ANALOGUE OF ALBITE, FROM THE GREEN RIVER FORMATION, UTAH: Am. Mineralogist, v. 45, no. 1/2, p. 188-199, 4 illus., map, 3 diags., 3 tables, Jan.-Feb. 1960, 6 refs.

Reedmergnerite, $NaBSi_3O_8$, is a B analogue of albite, occurring with eitelite, shortite, nahcolite, searlesite, leucosphenite, acmite, analcite, and magnesioriebeckite in unmetamorphosed dolomitic oil shales of the Green River formation in several oil wells in Duchesne County, Utah. It is triclinic, colorless, in stubby prisms with characteristic wedge-shaped ends; biaxial, negative, $2V = 80°$, indices of refraction α 1.554, β 1.565, γ 1.573, all $\pm$ 0.001. X-ray diffraction and crystallographic data are given.--Auth.

2-1537. Drysdall, A.R., and A.R. Newton. BLUE ASBESTOS FROM LUSAKA, NORTHERN RHODESIA, AND ITS BEARING ON THE GENESIS AND CLASSIFICATION OF THIS TYPE OF ASBESTOS: Am. Mineralogist, v. 45, no. 1/2, p. 53-59, 2 tables, Jan.-Feb. 1960, 12 refs.

An occurrence of blue asbestos near Lusaka was investigated and proved to consist of an anastomosing stockwork of predominantly slip-fiber veins in a semicalcareous host rock. The host rock is probably lenticular and occurs in a strongly deformed dolomite formation. Chemical analysis of the asbestos shows that it is magnesioriebeckite according to the classification of Miyashiro; the geological evidence strongly suggests that it is of

metasomatic origin. A similar occurrence has been described from Bolivia, and both are in strong contrast to the normal South African and Australian occurrences, where the asbestos is of riebeckite composition and probably of purely metamorphic origin. The name crocidolite has been widely used to describe blue asbestos, but as it applies only to fibrous varieties of riebeckite and magnesioriebeckite, it should not be applied as a mineral name.--Auth.

2-1538. Outerbridge, William F., Mortimer H. Staatz, Robert Meyrowitz, and Alfred M. Pommer. WEEKSITE, A NEW URANIUM SILICATE FROM THE THOMAS RANGE, JUAB COUNTY, UTAH: Am. Mineralogist, v. 45, no. 1/2, p. 39-52, illus., 5 tables, Jan.-Feb. 1960, 11 refs.

Weeksite, $K_2(UO_2)_2(Si_2O_5)_3 \cdot 4H_2O$, is a new uranyl silicate mineral named for Dr. Alice D. Weeks. It is a soft yellow nonfluorescent mineral with a waxy to silky luster, and it crystallizes chiefly in radiating fibrous clusters. In the Thomas Range, where it was first found, it occurs in opal veinlets in rhyolite and as replacements of pebbles in a tuffaceous conglomerate. Weeksite also has been identified from 8 other localities in Pennsylvania, Wyoming, California, New Mexico, Mexico, Arizona, and Texas.

Weeksite is biaxial negative 2V = about 60°; dispersion r>v, strong; $\alpha = 1.596$, $\beta = 1.603$, $\gamma = 1.606$; X = b, colorless, Y = c, pale yellow green, Z = a, yellow green. The measured specific gravity is about 4.1.

A chemical analysis of material from the Thomas Range showed: K_2O 5.5, Na_2O 0.7, BaO 1.4, CaO 1.1, UO_3 51.5, SiO_2 33.6, H_2O 6.6, Al_2O_3 0.6, CO_2 0.3; total 101.3%. A synthetic Na analogue of weeksite showed Na_2O 7.2, UO_3 52.0, SiO_2 33.9, H_2O (in part from wood) 8.1, C (from wood) 0.3; total 101.5%.

Weeksite is orthorhombic, pseudotetragonal; the space group is Pnnb-D^6_{2h}; a = 14.26 + 0.02 A, b = 35.88 + 0.10 Å, c = 14.20 + 0.02 A; a : b : c = .3974:1:.3958. Cell contents 16 $[K_2(UO_2)_2(Si_2O_5)_3 \cdot 4H_2O]$. The 9 strongest lines of the X-ray powder pattern of weeksite are: 7.11 (10), 5.57 (9), 8.98 (8), 3.55 (7), 3.30 (7), 2.91 (6), 3.20 (5), 2.37 (5), 2.28 (5); and those of the synthetic Na analogue are 7.11 (10), 5.57 (9), 9.03 (8), 3.56 (7), 3.30 (7), 2.94 (6), 3.19 (5), 2.37 (5), 2.28 (5).--Auth.

2-1539. Serdyuchenko, D. P. THE COMPOSITION AND STRUCTURE OF DUMORTIERITE: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 102-106, table, pub. 1959, 22 refs.

English translation of GeoScience Abstracts 1-468.

2-1540. Kamb, W. Barclay, and William C. Oke. PAULINGITE, A NEW ZEOLITE, IN ASSOCIATION WITH ERIONITE AND FILIFORM PYRITE: Am. Mineralogist, v. 45, no. 1/2, p. 79-91, 5 illus., 3 tables, Jan.-Feb. 1960, 9 refs.

A new zeolite, for which the name paulingite is proposed, has been found in vesicles in basalt from the Columbia River near Wenatchee, Washington. Paulingite is cubic, and occurs as perfect, transparent rhombic dodecahedra. The very large cubic cell has $a_o = 35.10 + .02$ Å, and the space group is probably $O_h^9 - Im\bar{3}m$. Ca and K are chief cations, but Ba and Na are also present. The atomic ratio of Si to Al is roughly 3. In association with the paulingite is the rare zeolite erionite. It occurs as relatively large acicular hexagonal prisms, and also as tufts of very fine fibres. The hexagonal unit cell has dimensions a = 13.27 + .02 Å, c = 15.05 + .02 Å, and the space group is either D_{6h}^4, C_{6v}^4, or D_{3h}^4. Erionite is a member of the chabazite group of zeolites. Also in association with the paulingite and erionite is pyrite of remarkable filiform habit.--Auth.

2-1541. Bassett, William A. ROLE OF HYDROXYL ORIENTATION IN MICA ALTERATION: Geol. Soc. America, Bull., v. 71, no. 4, p. 449-455, 2 col. illus., 3 charts, 2 diags., table, Apr. 1960, 3 refs.

Phlogopite and biotite are generally more susceptible to alteration by ion exchange than muscovite. The key mechanism responsible for this difference is considered to be hydroxyl orientation.

Single-crystal study with infrared spectrophotometer established the orientation and bonding of the hydroxyl ions. The dipole moments of the hydroxyl ions in phlogopite, a trioctahedral mica, are perpendicular to the cleavage, whereas those in muscovite, a dioctahedral mica, are obliquely oriented.

The hydroxyl ions in phlogopite absorb a higher frequency (3,700 Cm^{-1}) infrared than those in muscovite (3,600 Cm^{-1}). Biotite and Fe-rich phlogopite generally show absorption at 2 frequencies, which indicates both trioctahedral and dioctahedral configurations. The inclined hydroxyl ions in dioctahedral mica place the K ions in a more negative environment than the perpendicular hydroxyl ions in trioctahedral mica. The more negative environment binds the K ions more securely in the lattice.--Auth.

2-1542. Williamson, W.O. SOME EFFECTS OF DEFORMATION ON THE STRUCTURE AND PROPERTIES OF CLAY: Mineral Industries, v. 29, no. 7, p. 1, 3-5, 8, 4 illus., 3 diags., Apr. 1960, 20 refs.

The particles of many clay minerals are in the form of very small, flat platelets and thus may develop planar parallelism during deposition, or during mechanical working. Such parallelism induces vector properties, e. g., drying and firing shrinkages tend to be differential. These vector properties play an important role in ceramic fabrication processes.

The effects of artificial deposition or deformation on the microstructure of clays have significance not only for ceramists but for geologists interested in the natural fabrics of rocks.

Engineers, soil physicists, and others may postulate a structure for plastic clay which is unacceptable to many ceramists; a possible resolution of the conflict of opinion is suggested.--Auth.

2-1543. Zeitner, June Culp. RARE GEMS OF THE MIDWEST: Earth Sci., v. 13, no. 2, p. 58-62, illus., Apr. 1960.

Although the midwestern United States lacks the amount of gemstones found in the far West, it posseses a large variety of high-quality gem material. A brief description and locality designation is given of the following: thomsonite, chlorastrolite, datolite, Fairburn agate, Tepee Canyon agate, Superior agate, blue chalcedony, binghamite, dendritic opalite, Ohio flint, Petoskey stone, fresh-water pearls, gem fossils including cycad, Lepidodendron, osmundites, Iowa coral, and dendritic ivory.--M. Russell.

1544. Lapham, Davis M., and Alan R. Geyer. MINERAL COLLECTING IN PENNSYLVANIA: Pennsylvania Geol. Survey, Bull. G-33, 74 p, 58 figs. incl. illus., maps, 1959, approx. 45 refs.

The introductory topics covered in this bulletin relate the hobby of mineral collecting to the science of mineralogy and to various aspects of the science of geology. In addition to the usual definitions, special sections are devoted to the geologic associations of minerals and to the use of topographic maps. Twenty-eight of Pennsylvania's best collecting localities are described by county. Each description includes word and map location directions; the types, forms, and availability of minerals present; a brief, nontechnical geologic summary of the occurrence; and specific references to that locality. Selected general references, a list of museum collections open to the public, and a mineral index conclude the bulletin.--Auth.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Stratigraphy 2-1419; Geochemistry 2-1522.

1545. Friedman, Gerald M. CHEMICAL ANALYSES OF ROCKS WITH THE PETROGRAPHIC MICROSCOPE: Am. Mineralogist, v. 45, no. 1/2, p. 73-78, 2 tables, Jan.-Feb. 1960, 20 refs.

The chemical composition of the granite (G-1) was calculated from quantitative mineralogical (modal) analyses of petrographic thin-sections. The percentages of the major constituents, SiO_2, Al_2O_3, Fe_2O_3, FeO, MgO, CaO, Na_2O, and K_2O were computed. These calculations were compared with the results of wet chemical analyses made by 30 chemists in 25 analytical laboratories. Each constituent calculated from the thin-section analysis of the rock standard lies within the range reported by the chemists. The arithmetic mean of the percentage of each constituent determined by the chemical analyses agrees closely with the analysis calculated from the mode.

A norite sample was also analyzed by petrographic and chemical procedures. Agreement between the 2 techniques for this sample was close.

This study indicates that for rocks in which the composition of the individual minerals has been obtained by optical measurements, the major constituents can be determined with the petrographic microscope by modal analyses, and the results may be considered reliable.--Auth.

1546. Murata, K.J. A NEW METHOD OF PLOTTING CHEMICAL ANALYSES OF BASALTIC ROCKS: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 247-252, 4 diags., 1960, 15 refs.

In studying the differentiation of basaltic magmas by means of the chemical analyses of basaltic rocks, very useful diagrams are obtained by plotting percent CaO, MgO, or Na_2O+K_2O against the Al_2O_3/SiO_2 weight ratio. The diagrams show the tholeiitic and the alkalic series of basaltic rocks nicely separated and parallel in their variations. Fractional crystallization of clinopyroxene appears to be the principal mechanism by which tholeiitic magmas are converted to alkalic magmas.--Auth.

1547. Waters, A.C. DETERMINING DIRECTION OF FLOW IN BASALTS: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 350-366, 5 illus. on 2 pls., 5 figs. incl. secs., diags., 1960, 23 refs.

A number of structural features can be used to determine the direction of advance of individual lava flows in the great accumulations of flood basalts such as form the Columbia River plateau and the lava platform of the Oregon Cascades. Three are particularly valuable, however, because they are abundant, easily interpreted, and give unambiguous results: 1) inclined columnar joints in flow interiors pitch toward the source of the lava; 2) spiracles (also pipe vesicles and vesicle cylinders) rise from the bottoms of flows and bend or trail out downstream; and 3) primary foreset bedding develops in most palagonite complexes.--Auth.

2-1548. White, Walter S. THE KEWEENAWAN LAVAS OF LAKE SUPERIOR, AN EXAMPLE OF FLOOD BASALTS: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 367-374, sec., table, 1960, 19 refs.

Individual lava flows of Keweenawan (late Precambrian) age in the Lake Superior basin are characterized by volumes that may exceed 100 cu. mi. and by original surface slopes of the order of 10-20 ft. per mi. or less. In these respects they differ greatly from the flows of shield volcanoes from which so much of our knowledge of lava flowage stems. The volumes are estimated from field measurements. The slopes are estimated by subtracting reasonable initial dips of interbedded conglomerate beds (obtained by comparison with modern fan depcsits of similar coarseness) from the angle between top and bottom of flows overlying conglomerate beds, since the lava flows and the gravel-depositing streams are believed to have flowed in opposite directions. Difference in volume alone seems adequate to explain a number of the physical differences between the Keweenawan flood basalts and those of shield volcanoes without appeal to differences in composition, volatile content, or temperature.--Auth.

2-1549. Ham, William E. GLASSY PEBBLES IN SOUTHWESTERN OKLAHOMA - OBSIDIAN VS. TEKTITE: Oklahoma Geology Notes, v. 20, no. 4, p. 92-95, 3 illus., table, Apr. 1960, 5 refs.

A pebble, recently discovered at Lugert, Oklahoma, has the superficial appearance of a tektite. Consideration of the closely similar physical and chemical properties of tektites and obsidians shows that the pebble is an obsidian (principally because it has planar flow structure), as is also an earlier discovery from Delhi, Oklahoma, which has been reported to be a tektite.--A. Nicholson.

2-1550. Kudryashova, V.I. ON THE ORIGIN OF ELLIPSOIDAL LAVAS OF THE LOWER TUNGUSKA RIVER: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 87-92, 3 illus., secs., pub. 1959, 18 refs.

English translation of GeoScience Abstracts 1-470.

2-1551. Merlich, B.V. EXPLOSIVE BRECCIA DIKES OF TRANS-CARPATHIA: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 3, p. 41-50, 6 figs. incl. map, table, pub. 1959, 9 refs.

In the paper there are described the breccia dikes of Trans-Carpathia, previously regarded as tectonic. Proof is given of their explosive origin. According to the latest review, explosive dikes are not described in our literature, and data on such formations can only be obtained from American sources. Specific properties of explosive dikes are described, and the mechanism of formation of the dikes is outlined.--Auth.

2-1552. Zen, E-An. METAMORPHISM OF LOWER PALEOZOIC ROCKS IN THE VICINITY OF THE TACONIC RANGE IN WEST-CENTRAL VERMONT: Am. Mineralogist, v. 45, no. 1/2, p. 129-175, 6 diags., 5 tables, Jan.-Feb. 1960, 52 refs.

Rocks from the Taconic Range and adjacent areas, near Castleton in W.-central Vermont, have been studied for their mineral assemblages. Most of the rocks are argillaceous or arenaceous, of Early Cambrian to Middle Ordovician age, and are from the Taconic allochthone. A number of samples, including carbonates, are from the Lower Ordovician to Middle Ordovician rocks of the surrounding autochthonous marble belt. Regional metamorphism was later than the emplacement of the Taconic allochthone; the metamorphic grades in the Taconic sequence cut across structures and conform to the trend in the surrounding autochthone. The grade decreases from E. to W., and the rocks range correspondingly from phyllites to slates and shales.

Study of the mineralogy of the samples made use both of the X-ray diffractometer and the petrographic microscope. Two chlorite samples, 1 from a slate and 1 from a phyllite and a chloritoid sample from a phyllite, in addition to 4 rock samples, were chemically analyzed.

The most significant mineral assemblages found are: 1) muscovite-chlorite-quartz, 2) muscovite-paragonite-chlorite-chloritoid-quartz, 3) muscovite-chlorite-chloritoid-epidote-hematite-magnetite-quartz, 4) muscovite-stilpnomelane-chlorite-albite-microcline-quartz, 5) muscovite-biotite-quartz-graphite, 6) calcite-dolomite-chlorite-muscovite, and 7) calcite-zoisite-chlorite.

The prevalence of assemblage (1), with its simple mineralogy, indicates that chlorite may be variable in the (Fe, Mg)/Al ratio in addition to the Fe/(Fe+Mg) ratio. This is borne out by the chemical analyses; the analyzed chlorites are among the highest reported in their Al/(Fe, Mg) ratios.

The basal spacings of coexistent muscovite and paragonite in assemblage (2), found in the phyllites, are 9.97(5) Å and 9.62(3) Å, respectively, indicating very limited solid solution between these phases at this metamorphic grade. No paragonite has been found in the slates; it is suggested that paragonite may possess a lower limit of stability, with the more hydrous assemblage, kaolinite plus albite, taking the place of paragonite plus quartz.

Rocks relatively rich in Al contain chloritoid (2, 3), and the chloritoid-chlorite association is common even in slates. The chlorite is always more Mg-rich although the analyzed chloritoid also shows significant solid solution of Mg for Fe. The only sodic phase found with chloritoid is paragonite. Rocks relatively poor in Al do not have chloritoid but contain stilpnomelane (4), in addition to microcline which is incompatible with high-Al phases. The location of stilpnomelane on the low-Al part of the A-F-M diagram is based on regarding all Fe‴ in stilpnomelane as subsequently oxidized Fe"; this is justified by an analysis of the available chemical data on this mineral. Stilpnomelane- and chloritoid-bearing assemblages are mutually incompatible in the area; that the control is chemical composition rather than physical conditions of metamorphism is borne out by field mapping of the lithologic units. The stilpnomelane-microcline-chlorite assemblage rules out the chlorite-Fe biotite pair, which in fact is not found in the area although biotite does occur (5).

Data pertaining to phases in the A-C-F diagram are scanty. The mineral assemblages show, however, that chlorite may be the first mineral to form upon metamorphism of a quartzose and aluminous dolostone (6). The presence of the zoisite-calcite pair (7) indicates that the calcite-kaolinite pair, found in sedimentary rocks, ceases to be stable in the rocks of this area.

The analysis of the mineral assemblages in the Castleton area indicates that these rocks by and large have attained chemical equilibrium during metamorphism. The assemblages obey the Phase Rule, and no incompatible mineral pair has been found. Textural data on the rocks also suggest extensive recrystallization has occurred. Both H_2O and CO_2 may be treated as mobile components without violating the Phase Rule. Evidence, however, is inconclusive on the status of O_2.--Auth.

2-1553. Litsarev, M. A. GROSSULARITE-WILLASTONITE [SIC] SKARNS OF THE EMEL'DZHAK PHLOGOPITE DEPOSIT (SOUTH YAKUTIA): Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 3, p. 26-40, 3 illus., sec., diag., 4 tables, pub. 1959, 19 refs.

This paper presents the results of studies on grossularite-wollastonite skarns, which are unusual for the Archean complex of the Aldan massif. The geologic distribution of the skarns and their structure and mineral composition are discussed. A description of the minerals and their behavior in individual diffusive metasomatic zones is given. The problem of extent and depth of the system is also discussed.--Auth.

2-1554. Burge, Donald L. INTRUSIVE AND METAMORPHIC ROCKS OF THE SILVER LAKE FLAT AREA, AMERICAN FORK CANYON, UTAH: Brigham Young Univ., Dept. Geology, Brigham Young Univ. Research Studies, Geology Ser., v. 6, no. 7, 46 p., 9 pls. incl. illus., maps (1 fold. geol. map), sec., Aug. 1959, 21 refs.

This report concerns 10 sq. mi. in the Silver Lake Flat area. Most of the area, which includes the southeastern part of the Little Cottonwood stock of quartz monzonite and associated metamorphosed Precambrian and Paleozoic sediments, is situated on the southern slope of the divide between American Fork Canyon and Little Cottonwood Canyon.

Metamorphism of the thin mantle of Mississippian limestones overlying the southeastern margin of the stock produced a striking suite of metamorphic minerals. The limestones were divided into 4 zones in order of increasing metamorphism: Zone 1, unmetamorphosed dark gray, slightly dolomitic limestone; Zone 2, dark gray to black amphibolic limestone containing abundant graphite; Zone 3, white to light gray siliceous limestone characterized by the presence of wollastonite, diopside, and idocrase; and Zone 4, abundant brown garnet with lesser amount of olivine, epidote, zoisite, serpentine, and microcline. Zone 2 represents a simple rearrangement of elements existing in a premetamorphosed limestone similar in composition to that of Zone 1,

hereas the limestones of Zones 3 and 4 have been rongly altered by the metasomatic introduction of rge amounts of silica and smaller amounts of Al, g, and Fe. C and carbonate were eliminated from e 2 zones nearest to the intrusive contact, probably the form of volatile compounds. A change in omic structure of the diagnostic minerals with creasing metamorphic rank is represented by the edominance of the double chain inosilicate struc- re in Zone 2, the single chain inosilicate structure Zone 3, and the independent tetrahedral ortho- licate structure in Zone 4.

Prismatic amphiboles characteristic of Zone 2 ow preferred orientations of axes concentrated in dding planes of the limestone, with directions arallel to the strike and at right angles to the strike the bedding. The most frequent orientation of the es occurs at right angles to the strike of the bed- ng in a northwestern direction, closely paralleling line drawn toward the center of the stock. The W. axes were probably orientated by slippage along e bedding planes of the limestone resulting from resses that radiated from the stock during its trusion. Orientation of amphibole axes along the trike of the limestone bedding was most likely due to secondary slippage produced by tensional stresses working at right angles to the compressive stresses.

Mines in the area have produced moderate amounts of Pb, Zn, and Ag in the past, but are presently inactive. Most of the ore production has been from northeasterly striking fissures in the Tintic quartzite.--Auth.

2-1555. Afanasev, G.D., and S.G. Tseytlin. ROCK RADIOACTIVITY STUDY IN THE NORTHERN CAUCASUS AND ITS IMPORTANCE FOR CERTAIN PETROLOGIC PROBLEMS (PRELIMINARY CONCLUSIONS): Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 3, p. 12-25, graph, 10 tables, pub. 1959, 22 refs.

A schematic representation is given of the accepted separation of magmatic rocks in the N. Caucasus into complexes of various age and their distribution in the structural zones of the N. Caucasus folded province. The following 4 magmatic complexes are recognized 1) Cenozoic (Tertiary-Quaternary), 2) Mesozoic (Jurassic-Cretaceous), 3) upper Paleozoic (lower Carboniferous-Permian) 4) Urushten (Cambrian-Lower Devonian). Numerous age determination data are given.--M. Russell.

10. SEDIMENTARY PETROLOGY

ee also: Structural Geology 2-1376; Stratigraphy 2-398; Mineralogy 2-1527, 2-1542; Engineering Geology -1618.

-1556. Flint, Richard Foster, John E. Sanders, nd John Rodgers. SYMMICTITE: A NAME FOR ONSORTED TERRIGENOUS SEDIMENTARY ROCKS HAT CONTAIN A WIDE RANGE OF PARTICLE IZES: Geol. Soc. America, Bull., v. 71, no. 4, . 507-509, Apr. 1960, 12 refs.

Existing terminology of till-like sedimentary eposits tends to emphasize genesis without consid- ring all possible modes of origin and to suggest elationships to tillite that may be erroneous. Therefore new terms (symmicton for sediment; symmictite, or lithified equivalents) are proposed as general names for essentially nonsorted, noncalcareous, errigenous deposits composed of sand and/or larger articles in a muddy matrix.--Auth.

-1557. Tourtelot, Harry A. ORIGIN AND USE F THE WORD "SHALE": Am. Jour. Sci., v. 258-A (Bradley Volume), p. 335-343, 1960, 42 refs.

Shale is a word of Teutonic origin that developed ts meaning of "laminated clayey rock" in the English ining district of Derbyshire. The first recorded se is in 1747, but clearly the term is much more ncient. By the first few years of the 19th century, t had superseded a number of local names as well s the classically derived schistus, which the early atural philosophers were accustomed to use. By the nd of the 19th century, it was nearly the only term pplied to clayey rocks of Jurassic age and older in ngland and to clayey rocks of all ages in the United tates, except for the coastal plain strata of Creta- eous and Tertiary age. The word is now looked on ith some disfavor because we use it both as the lass name for fine-grained rocks and more precisely s the name for laminated clayey rocks. Both of hese uses, however, seem permissible and justifi- ble.--Auth.

-1558. Pryakhina, Yu. A. CARBONATE CONRETIONS IN THE MAYKOP DEPOSITS OF THE CENTRAL CIS-CAUCASUS: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 1, p. 18-31, 13 figs., incl. 5 illus., 3 maps, graphs, diag., 4 tables, pub. 1959, 6 refs.

Four groups of carbonate concretions occur in the Maykop deposits of the central Cis-Caucasus and, based on their chemical, mineral, and petrographic properties, are divided as follows: 1) clay siderites, 2) clay-phosphate siderites, 3) clay ankerites, and 4) clay calcites. The enclosing sediments are marine, deposited in a reducing environment.--M. Russell.

2-1559. Bagnold, R.A. SEDIMENT DISCHARGE AND STREAM POWER - A PRELIMINARY ANNOUNCEMENT: U.S. Geol. Survey, Circ. 421, 23 p., 1960.

This report describes sediment transport by water streams and, by reasoning, extends the simplest conditions of uniform grain size and steady flow to natural materials and unsteady flow. Sediment discharge is discussed as a function of stream power measured by a function of discharge and slope.--U.S. Geol. Survey.

2-1560. McKee, Edwin D. CYCLES IN CARBONATE ROCKS: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 230-233, fig., 1960, 10 refs.

Sedimentary cycles are readily recognized in rock sequences involving both marine and continental strata and to a lesser extent in strata that are entirely marine but include both carbonate and detrital types. In rock sequences composed entirely of carbonate rock, cycles commonly can be detected by trends in the size and abundance of terrigenous components. In carbonate formations that are largely devoid of detrital minerals, however, cycles must be established on the basis of differences in size of clastic carbonate grains which may indicate differences in turbulence but are not necessarily the results of transportation. Trends in distribution obtained from a detailed analysis of cycles, however,

may indicate whether the position of various size grades has been determined by transportation or by environment.--Auth.

2-1561. Cloud, Preston E., Jr. GAS AS A SEDIMENTARY AND DIAGENETIC AGENT: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 35-45, 13 illus., 1960, 38 refs.

Gas can be a significant factor in the transportation and alteration of sediments, and traces of its former presence may convey useful information about the depositional and diagenetic history of sedimentary rocks. Transportation of sediment by gas is probably most important in embayed littoral environments of broad extent and reduced offshore drainage, hence onshore transport and shoreward decreasing grain size. Stranded, blown, or drifting bubbles and evasion of upwelling gas are responsible for a variety of imprints and structures in sediments. The relations to other features of impressions of gas blisters at the base of a thin Devonian graywacke are analyzed and found to support deposition of the graywacke from a weak suspension current. Concentration of pyrite in irregularly subcylindrical structures within a Devonian limestone contributes to the interpretation of these structures as former sites of gas accretion. Relations between pyrite, matrix, and later mineralization reveal the main steps in the diagenetic history of the limestone. Some ancient sedimentary features that have been interpreted as raindrop imprints, tracks and burrows, and Precambrian jellyfish are probably also the work of gas.--Auth.

2-1562. Lovering, T.S., and Anna O. Shepard. HYDROTHERMAL ALTERATION ZONES CAUSED BY HALOGEN ACID SOLUTIONS, EAST TINTIC DISTRICT, UTAH: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 215-229, 6 illus., chart, 9 profiles, 3 tables, 1960, 6 refs.

On the Helen claim in Homansville Canyon in the East Tintic district, a small deposit of clay typical of argillic alteration, together with fluorite, diaspore, quartz, hematite, and manganese oxides, occurs at the intersection of a minor N.-S. fissure with a steep ENE.-trending contact of Tertiary quartz latite lava and dolomitized Cambrian Herkimer limestone. The fissure ends at a small completely argillized monzonite plug about 100 yds. to the N.

Hydrothermally altered rocks are scattered through the roots of the deeply eroded Eocene volcanic field in which the East Tintic and Tintic districts lie, but in most areas of argillic alteration, abundant pyrite or alunite and barite suggest that the alteration was caused largely or in part by S acids, whereas in the Helen claim these minerals are virtually lacking.

Mineral zones parallel the lava-dolomite contact: the lava is strongly argillized in a zone about 4 ft. wide, which has much montmorillonite and a small amount of kaolinite. The dolomite outward from its contact with the lava has been replaced by hematite and quartz in a zone 5-8 ft. wide, which merges on the far side with a manganiferous zone 1-3 ft. thick containing abundant quartz, manganese oxides and hematite, minor manganapatite, and kaolin minerals; farther from the contact, a fluorite-kaolin-diaspore zone, a diaspore-kaolin-fluorite zone, a kaolin-diaspore-fluorite zone, and a kaolin-mica zone appear successively. The edge of the dolomite is changed to a weakly bonded granular dolomite with some kaolin and mica; beyond this zone hard fresh hydrothermal dolomite extends outward for several hundred feet.

The field relations of the alteration zones, together with X-ray, mass spectrograph, and petrographic studies, suggest reaction with acid emanations carrying halides of Fe, Al, and Si at temperatures up to 300°C. The zoning is appropriate to precipitation responsive to an increasing pH caused by reaction with the carbonate wall rock.--Auth.

2-1563. Grim, Ralph E., Georges Kulbicki, and Albert V. Carozzi. CLAY MINERALOGY OF THE SEDIMENTS OF THE GREAT SALT LAKE, UTAH: Geol. Soc. America, Bull., v. 71, no. 4, p. 515-519, map, Apr. 1960, 3 refs.

The modern lake sediments and those of post-Provo age immediately preceding the present Great Salt Lake have about the same clay-mineral composition. In these deposits, the montmorillonite shows a relatively poor organization which may be a consequence of the presence of considerable Na. The montmorillonite may be either detrital or precipitated or formed by alteration of volcanic ash.

The illite, probably detrital, is generally well organized showing only a very small amount of degrading. The presence of kaolinite in all the lake samples is noteworthy. It is almost certainly detrital. There is a general absence of substantial mixed-layer components as well as of any chlorite, and there is no suggestion of attapulgite-sepiolite clay minerals.

The Alpine and Provo sediments of the Lake Bonneville terraces have a clay-mineral composition somewhat different from that of the modern lake sediments; they show a highly degraded chlorite and a very well-ordered montmorillonite.

The green clays of early Pleistocene age also have a distinctive clay-mineral composition corresponding to a high content of illite and a low content of montmorillonite associated with the presence of chlorite.

The clays occurring in the Great Salt Lake desert W. of Knolls contain at a depth of about a foot a thin bed of nearly pure, unconsolidated dolomite.--Auth.

2-1564. Terriere, Robert T. GEOLOGY OF GROSVENOR QUADRANGLE, TEXAS, AND PETROLOGY OF SOME OF ITS PENNSYLVANIAN LIMESTONES: U.S. Geol. Survey, Repts., Open-File Ser., no. 505, 171 p., 28 figs. incl. 2 maps, secs., diags., 10 pls. incl. illus., geol. map (in pocket), sec. (in pocket), 2 graphs (in pocket), Jan. 1960, 45 refs.

The geology of the Grosvenor quadrangle, Brown and Coleman counties, has been mapped as a part of a systematic mapping program by the U.S. Geological Survey. In support of stratigraphic studies of the rocks of the area, detailed petrographic examinations were made of key limestone beds.

The quadrangle is underlain by Pennsylvanian and lower Permian sedimentary rocks that dip gently to the WNW., overlapped by isolated patches of Lower Cretaceous strata which dip slightly to the SE., and covered by Quaternary alluvium along stream valleys. The Pennsylvanian and Permian rocks consist mainly of gray shale, but also contain limestone, siltstone, sandstone, conglomerate, and red shale. The sandstone and conglomerate occupy broad, shallow channels cut during Pennsylvanian and early Permian time. Shale and siltstone also fill parts of some channels.

These rocks belong to the Canyon, Cisco, and chita groups, in ascending order. The Canyon oup contains thicker limestone units and a larger portion of limestone than the Cisco and Wichita oups, but has few channel deposits. Channel posits are numerous in the Cisco and Wichita, pecially in the lower part of the Wichita. Where nnel deposits are superimposed on one another, y can be differentiated only by detailed study of ir relationships to limestone beds. Smaller nnels that seem to be the result of local cut and occur within some of the main channels.

Limestone units form a small part of this sence, but are of particular interest because they nstitute distinctive marker beds and because much ker Pennsylvanian and Permian limestone units important oil and gas reservoirs in western xas. Seven limestone units in the Bluff Creek d Gunsight members of the Graham formation of Cisco group, considered representative, were ected for detailed study. Smoothed and etched faces, insoluble residues, and thin sections re studied with the aid of binocular and petroaphic microscopes. Point counts were made to ermine the abundance of the various organic and rganic components. Shale and sandstone asciated with the limestone units were studied efly.

The limestone beds are composed of 1) interstitial lcite ooze and sparry calcite cement, 2) grains or gregates (allochems), including fossils, oöliths, lets, and reworked limestone fragments (intrasts), 3) terrigenous sand, silt, and clay, and 4) authigenic chert, barite, pyrite, ankerite, hematite, limonite, and psilomelane(?). The limestone beds are predominantly made up of fossils and fossil fragments in a mixture of calcite ooze and cement. The constituents most diagnostic of certain units are fusulinids, algae, corals, and the insoluble residues. The relative amounts of these constituents, along with texture and field appearance, were used to divide the limestone samples into 4 types.

Type I is unsorted, unwinnowed limestone with many fusulinids, dark gray where fresh but orange where weathered. It contains finely disseminated pyrite, suggesting little water circulation and hence deposition below wave base. Type II limestone is aphanitic and has many recrystallized algae and veinlets of sparry calcite. Locally it contains many horn corals. Probably type II limestone was deposited in extremely shallow water where waves were small and conditions were most favorable for chemical precipitation of carbonate ooze.

Type III limestone contains abundant evidence of strong wave action: sorting and rounding, reworked fossils, intraclasts, oöliths, and relatively large amounts of terrigenous sand. This type has erratic distribution and probably originated on offshore bars. Type IV limestone is light gray, aphanitic, and contains few fusulinids or algae, but much poorly sorted and poorly preserved fine fossil debris, especially smaller Foraminifera. Field relations between type IV and type I limestone suggest that they are regressive and transgressive equivalents, respectively, formed in otherwise the same environments.--Auth.

11. GEOHYDROLOGY

e also: Geochemistry 2-1523; 2-1525; Sedimentary trology 2-1559.

1565. Leopold, Luna B. CONSERVATION AND ATER MANAGEMENT: U.S. Geol. Survey, Circ. 4, 4 pts., 1960.

A series of 4 brief, general addresses, presented fore various groups in the United States during 58 and 1959: Pt. A. Conservation and Protection; B. The Challenge of Water Management; Pt. C. e Conservation Attitude; Pt. D. Ecological Systems d the Water Resource.

1566. Magin, George B., Jr., and Lois E. ndall. REVIEW OF LITERATURE ON EVAPORAON SUPPRESSION: U.S. Geol. Survey, Prof. per 272-C, p. 53-69, 1960, 322 refs.

Evaporation suppression is the reduction of evapation by controlling the rate at which water vapor capes from water surfaces. The need for water ving is greatest in areas of little rainfall and low noff. Water losses by evaporation from storage servoirs must be minimized for greatest utility limited supplies.

A review of the literature shows that evaporation n be retarded by either physical or chemical eans. It can be controlled by enclosure in a build-g, application of plastic covers, oil films, and onomolecular films.

Monomolecular films hold the greatest promise r use on large areas of water such as reservoirs. rom the literature available it is apparent that ese films introduce many chemical and physical oblems. The suppressants must be nontoxic and odorless, especially if used on water-supply reservoirs. They should allow the free exchange of O so that aquatic life is not endangered. The effects of water-borne bacteria on these films and the effects of the films on water of different qualities are not fully known. The physical problem of detecting the presence of the film has not yet been solved. Of the monomolecular films that have been investigated, the waxy alcohols such as hexadecanol and octadecanol show the greatest promise.--Auth.

2-1567. Stallman, Robert W. NOTES ON THE USE OF TEMPERATURE DATA FOR COMPUTING GROUND-WATER VELOCITY: U.S. Geol. Survey, Ground Water Notes, no. 39, 17 p., diag., Jan. 1960, 4 refs.

Analytical methods now in use for calculating the hydraulic constants of aquifers require the direct measurement of water velocity along some known boundary. This requirement limits the possibility of field determination of the desired constants to those areas where adequate testing facilities are available. Indirect methods of measuring groundwater velocity may serve to reduce this limitation.

The simultaneous transfer of heat and water underground results in head and temperature distributions amenable to description by differential equations. A sample equation is derived for a system isotropic and homogeneous to heat and fluid flow. Sample computations show that, for a "typical" set of conditions in water-bearing formations, the ground-water velocity has an appreciable influence on the underground temperature distribution. Thus it appears feasible to utilize temperature measure-

ments for calculating flow velocity. Also, a combination of head and temperature measurements might be used for calculating aquifer permeability.--Auth.

2-1568. Bear, Jacob. SCALES OF VISCOUS ANALOGY MODELS FOR GROUND WATER STUDIES: Am. Soc. Civil Engineers, Hydraulics Div., Jour., v. 86, no. HY2, pt. 1, p. 11-23, 6 diags., Feb. 1960, 13 refs.

Scales for viscous fluid models used for studying various problems of flow through porous media are described. Consideration is given to some model techniques and limitations. The discussion covers scales for length (including distorted scales), time, discharge, volume, storage coefficient, 2 liquid flows, and capillary effects.--Auth.

2-1569. Nixon, Paul R., and G. Paul Lawless. TRANSLOCATION OF MOISTURE WITH TIME IN UNSATURATED SOIL PROFILES: Jour. Geophys. Research, v. 65, no. 2, p. 655-661, 6 graphs, 6 tables, Feb. 1960, 3 refs.

Downward translocation of moisture in soil profiles under various types of natural vegetation and a denuded plot was observed during a prolonged rainless period. Moisture determinations were made to 20-ft. depths with a neutron-scattering moisture meter. The observations were made as part of a study of ground-water recharge by deep penetration of rain water. The significant magnitude that translocated moisture may reach is illustrated by data obtained in sand under brush cover. In this case, deeply translocated moisture was equal to 159% of evapotranspiration during the first rainless month. Approximately 31% of the moisture content of a 20-ft. profile under a denuded plot was lost by downward movement from the first to the 240th day of a rainless period. The moisture content W of various soil layers under the plot varied with the T according to the relation $W = a\,T^{-b}$.--Auth.

2-1570. Kirkham, Don. SEEPAGE INTO DITCHES FROM A PLANE WATER TABLE OVERLYING A GRAVEL SUBSTRATUM: Jour. Geophys. Research, v. 65, no. 4, p. 1267-1272, 3 figs., 2 tables, Apr. 1960, 4 refs.

The problem of flow of ponded water over a stratum of homogeneous soil overlying a stratum of gravel, the gravel in turn overlying an impermeable layer, is solved for the case in which equally spaced ditches penetrate into the gravel. Flow nets are obtained, as are formulas giving the quantity of water seeping through the ground into the ditches. The theory shows that unless the ditches are closer together than about 3 times the depth of the stratum of soil overlying the gravel, the proportion of water entering the ditches through the ditch walls is small compared with that reaching the ditches by way of the underlying gravel stratum.--Auth.

2-1571. Luthin, James N., and J.W. Holmes. AN ANALYSIS OF THE FLOW OF WATER IN A SHALLOW, LINEAR AQUIFER, AND OF THE APPROACH TO A NEW EQUILIBRIUM AFTER INTAKE: Jour. Geophys. Research, v. 65, no. 5, p. 1573-1576, 3 figs., table, May 1960, 5 refs.

The problem of predicting changes in the water table due to changes in the amount of water supplied is analyzed for a specific case. The differential equation describing the situation is

$$(\epsilon/k\,m)\,\partial\phi/\partial t = \partial^2\phi/\partial x^2 - A/k$$

where ϵ is a storage factor, k the hydraulic conductivity, m the thickness of the aquifer, ϕ the hydraulic head, and A the steady-state loss due to deep seepage and/or evapotranspiration.

The Laplace transformation is used for solving the above equation, subject to an appropriate set of boundary conditions.--Auth.

2-1572. Wood, Perry R., and George H. Davis. GROUND-WATER CONDITIONS IN THE AVENAL-McKITTRICK AREA, KINGS AND KERN COUNTIES, CALIFORNIA: U.S. Geol. Survey, Water-Supply Paper 1457, 6 maps (3 in pocket), 3 secs. (in pocket), diag., 7 graphs (1 in pocket), 10 tables, 1959, 47 refs.

The Avenal-McKittrick area consists of about 850 sq. mi. on the SW. side of the San Joaquin Valley. It extends southeastward from the towns of Avenal and Kettleman City to the Elk Hills. Except for about 16,000 acres in several isolated localities, the area is uninhabited desert most of the year, although extensive grazing is carried on during winter and spring. The area includes Kettleman and Antelope plains, Antelope and McLure (also known as Sunflower) valleys, and the area S. of Tulare Lake.

The geologic units of the area are classed as consolidated rocks and unconsolidated deposits. The first group includes consolidated non-water-bearing rocks and semiconsolidated rocks of Jurassic to Pliocene age which in general contain connate water of poor quality; locally at shallow depth fresh water is present in them. Most of the formations contain fold- and fault-induced fractures, and these openings probably convey small quantities of water to the adjacent unconsolidated deposits. The second group consists of unconsolidated to loosely consolidated water-bearing deposits of continental origin which supply nearly all the water pumped from wells. These deposits include the structurally deformed Tulare formation of late Pliocene and Pleistocene(?) age and the alluvium of Pleistocene and Recent age, which in most places unconformably overlies the Tulare. Both units are composed of generally poorly sorted silty materials containing lenticular bodies of sand and gravel derived from the Coast Ranges and deposited by streams on extensive alluvial fans. The alluvium is only moderately permeable, and, although the water-bearing properties of the Tulare are little known, it probably is also only moderately permeable. Lacustrine and flood-basin sediments of Pleistocene and Recent age, present in the bed of Tulare Lake and along Buena Vista slough, consist of nearly flat-lying well-stratified silt, clay, and fine sand which generally are poorly permeable.

The alluvium and the Tulare formation range in thickness from a few feet along the western border of the valley to several thousand feet beneath the valleys and plains. However, because of comparatively late structural deformation in the area, the deposits vary considerably in thickness for short distances. Over the crests of buried anticlines the deposits thin considerably, and along the flanks and in adjoining synclinal troughs they thicken rapidly.

Recharge to the unconfined and semiconfined bodies of ground water may be by seepage loss from streams, by deep penetration of imported water applied for irrigation in excess of plant requirements,

losses of imported water through irrigation nals and ditches, and by deep penetration of rain- l. However, seepage loss from intermittent reams draining the Coast Ranges probably is the ief source of recharge. Poorly defined drainage annels that extend generally eastward across the ea suggest that little water escapes as surface tflow. Inasmuch as annual precipitation averages ss than 12 in., deep penetration of rainfall is a gnificant source of recharge only during infrequent ars of exceptionally large precipitation.

Although the general movement of ground water northeastward from recharge areas along the estern border of the valley toward Buena Vista ough in the trough of the valley, the movement is terrupted or deflected in several places by north- estward-trending anticlinal structures, principally ose underlying the Pyramid, Kettleman, and Lost lls. Movement is restricted in the narrow Dagany d Avenal gaps and the area between the Kettleman d Lost hills. Local pumping depressions have veloped in McLure and Antelope valleys.

Of the 344 wells that were investigated in the eld in 1951 and 1955, only 95 were used as irriga- on wells in the autumn of 1955. Short-term draw- wn and recovery tests made by the Pacific Gas and lectric Co. indicate that the yields ranged from out 100 to 1,700 g.p.m. (gallons per minute). ecific capacities ranged from 2 to 120 g.p.m. per of drawdown. The depths of irrigation wells nged from about 100 to 1,700 ft.

Irrigation pumpage by electrically powered pumps creased steadily from about 13,000 acre-ft. in 47 to about 25,000 acre-ft. in 1953. From 1953 to 56 the annual pumpage remained nearly constant, out 25,000 acre-ft. The total for the 10-year peri- d was about 200,000 acre-ft.

In areas of large withdrawals water levels have ndergone steady and marked declines. For the eriod 1936-1953, the levels at Devils Den ranch eclined a maximum of about 100 ft.; for the period 51-1956, levels in Antelope Valley declined a aximum of 40 ft.; and for the period 1947-1954, evels in McLure Valley declined 60 to 120 ft. In e areas of little ground-water development E. of venal gap and throughout most of Kettleman and ntelope plains, water levels remained essentially nchanged to 1955, the date of this report.

The stream waters tributary to the Avenal-McKit- ick area differ greatly in both chemical character nd mineral content. They were divided into 2 gen- ral types on the basis of their chemical character. he waters of Avenal and Polonio creeks are char- cterized by a comparatively lower mineral content nd proportionally less sulfate but more Mg than the aters of Bitterwater, Media Agua, and Carneros reeks. These differences in mineral content are elated to the lithology of the rocks in the respective rainage areas. The waters in which the concentra- ion of sulfate is relatively low were derived from reas underlain predominantly by marine sediments f Cretaceous age and sedimentary, igneous, and netamorphic rocks of the Franciscan formation of urassic and Cretaceous age. The waters charac- erized by a high proportion of sulfate were derived rom areas underlain chiefly by marine and conti- ental sedimentary rocks of Tertiary and Quaternary ge.

The ground waters of the area are fairly consist- nt in chemical character but differ greatly in min- ral content. The typical waters are of sodium sul- ate composition or are sulfate waters of intermedi- te cation composition. Locally, sodium chloride waters are present. The mineral content of ground waters in the area ranges from 477 to 7,040 p.p.m. (parts per million), hardness ranges from 30 to 3,020 p.p.m. and B from 0.3 to 11 p.p.m. The high Na content of the ground waters in comparison to that of the stream waters evidently is the result of cation exchange with the sediments.

In most of the area the ground waters are of doubtful to unsuitable quality for irrigation. Further detailed studies of soil salinity and quality of ground water, and exploration and testing of undeveloped parts of the area will be required to determine whether ground-water supplies or ground-water storage can be utilized effectively in conjunction with imported surface-water supplies.--Auth.

2-1573. Sherwood, C.B. GROUND-WATER RESOURCES OF THE OAKLAND PARK AREA OF EASTERN BROWARD COUNTY, FLORIDA: Florida Geol. Survey, Rept. Inv. no. 20, 40 p., 9 maps, diag., 9 graphs, 4 logs, 2 tables, 1959, 13 refs.

The Biscayne aquifer is the source of all fresh ground water in the Oakland Park area. This aquifer extends from the land surface to more than 215 ft. below mean sea level and is composed chiefly of sandy marine limestone, calcareous sandstone, and beds of fine to medium quartz sand. The aquifer differs from place to place, but, in general, most of the layers of limestone and sandstone occur at depths below 60 ft. The permeability of the aquifer increases with depth.

Wells for small supplies generally obtain water at depths ranging from 60 to 80 ft., whereas wells for large supplies usually obtain water from the interval between 100 and 200 ft. Large-diameter wells obtain as much as 1,000 g.p.m. (gallons per minute) from the lower part of the aquifer.

Chemical analyses of ground-water samples indicate a hard limestone water that is suitable, naturally or with treatment, for most ordinary uses. Periodic determinations of chloride content of the ground water show that some salt-water encroachment has occurred in areas near the coast and in the Middle River basin.

Pumping-test data for deep wells in the Prospect well field area indicate approximate aquifer coefficients of transmissibility and storage of 2,000,000 g.p.m. per ft. and 0.015, respectively. However, the data indicate also that the hydraulic characteristics of the aquifer are complicated by the presence of beds of sand, silt, and clay in the upper 100 ft. of the aquifer and by recharge from surface-water sources. Quantitative data and areawide water-level and salinity data indicate that large quantities of ground water are available for future development if salt-water encroachment can be effectively controlled.--Auth.

2-1574. Peek, Harry M. THE ARTESIAN WATER OF THE RUSKIN AREA OF HILLSBOROUGH COUNTY, FLORIDA: Florida Geol. Survey, Rept. Inv. no. 21, 96 p., 15 maps (1 fold.), 2 secs., diag., 31 graphs, 7 tables, 1959, 17 refs.

The Ruskin area is defined to include about 200 sq. mi. in southwestern Hillsborough County. Sand, limestone, and shells of Pleistocene and Pliocene age crop out and vary in thickness from a few feet to about 60 ft. These deposits are underlain by Hawthorn formation (middle Miocene) which varies in thickness from less than 10 ft. in the northern part to more than 150 ft. in the southern part. The

Tampa formation (early Miocene) underlies the Hawthorn. Other formations encountered in water wells are the Suwannee limestone (Oligocene), Ocala group (upper Eocene) and Avon Park limestone (middle Eocene).

The Hawthorn and younger sediments are the source of some domestic and other small water supplies, but the large quantities of water required for irrigation and industrial use are obtained from older limestones. Suwannee limestone and Tampa formation are the principal sources of artesian water. The water in these formations occurs in permeable zones, separated by relatively impermeable beds. The water is replenished by rainfall in western Polk County and eastern Hillsborough County. The artesian aquifer has a transmissibility coefficient of about 115,000 g.p.d. per ft. and a storage coefficient of about 0.0006.

Significant fluctuations of artesian-pressure head result from daily and seasonal variations in withdrawal of water. The artesian-pressure head declined progressively in the coastal area during a period of extensive agricultural development from 1950 to 1952. Since 1952, however, seasonal fluctuations have decreased in magnitude, and a slight progressive rise in artesian head has occurred locally, as a result of a decrease in withdrawals. Records of water levels in wells not affected by local variations in discharge indicate that, regionally, the artesian head declined progressively in 1955-1956.--H. S. Puri.

2-1575. Peek, Harry M. RECORD OF WELLS IN THE RUSKIN AREA OF HILLSBOROUGH COUNTY, FLORIDA: Florida Geol. Survey, Inf. Circ. no. 22, 85 p., fig., pl., 2 tables, 1959.

This publication is a companion report to "The Artesian Water of the Ruskin Area of Hillsborough County, Florida" by the same author (see abstract above). This report contains tables of well records compiled during investigation of the artesian water in the Ruskin area.--H. S. Puri.

2-1576. Mogg, Joe L., Stuart L. Schoff, and E. W. Reed. GROUND WATER RESOURCES OF CANADIAN COUNTY, OKLAHOMA: Oklahoma Geol. Survey, Bull. 87, 112 p., 4 maps (2 in pocket), graph, 9 tables, 1960, 36 refs.

Canadian County, in central Oklahoma, has an area of 891 sq. mi. The average annual precipitation is about 29 in., and the normal annual temperature is about 60°F. Farming is the principal occupation and wheat the major crop. Production of oil and gas from the West Edmond pool, flour milling companies, the railroad shops at El Reno, and the Mustang power plant near Lake Overholser are the principal industries.

The rocks at the surface range in age from Permian to Quaternary. The primary purpose of this investigation was to determine the water-bearing properties of the Quaternary terrace deposits and alluvium along the North Canadian River, but the water-bearing character of the Permian rocks also was studied.

Alluvium and terrace deposits consist of interfingering lentils of clay, sandy clay, sand, and gravel. The average thickness of the saturated materials encountered in 156 test holes drilled into the alluvium of the North Canadian River valley was 27 ft. The alluvium of the North Canadian River is the source of water supply for the municipalities of El Reno, Yukon, Okarche, Geary, and Calumet. Oklahoma City supplements its surface-water supply with water from the alluvium, and the Concho Indian Reservation gets its water from the same source. Additional users are the Mustang power plant, which uses ground water for cooling purposes, and irrigation farmers, with 15 wells which are used to irrigate 609 acres in the river valley. The water in the alluvium and terrace deposits of both river valleys is generally hard and locally contains excessive quantities of sulfate. Yields from wells in these deposits may be as much as 600 g.p.m., depending upon the amount of saturated sand and gravel present and the construction of the well.

Wells in the Rush Springs sandstone, which crops out in the southwestern part of the county, may be expected to yield up to 80 g.p.m. depending on the thickness of the saturated sandstone present. Water from these sandstones is used for domestic purposes. The other Permian rocks in the county are considered to be poor aquifers which yield small amounts of highly mineralized water.

Aquifer tests were made on 3 wells in the alluvium of the North Canadian River valley. Results of these tests showed that the average coefficient of permeability is about 1,000 g.p.d. per sq. ft.; and the coefficient of storage, within range of fluctuation of the water table due to pumping wells, is about 0.10. For the entire thickness of water-bearing material, 0.15 is considered to be a better estimate of the average coefficient of storage.

The "safe yield" of the alluvium and terrace deposits is estimated tentatively to be about 270 acre-ft. per sq. mi. per year, This is based on an estimated recharge of 17.5% of the normal rainfall in the area and on the assumption that all of the natural ground-water discharge could be salvaged. The major part of the natural discharge is due to transpiration by phreatophytes. These phreatophytes, which consist principally of willows and cottonwoods along the North Canadian River, discharge about 40,000 acre-ft. per year - 6 times the present discharge by pumping. The amount of water stored in the alluvium and terrace deposits of the North Canadian River averages about 3,000 acre-ft. per sq. mi.--Auth.

2-1577. LeGrand, Harry E. GEOLOGY AND GROUND-WATER RESOURCES OF PITTSYLVANIA AND HALIFAX COUNTIES, VIRGINIA: Virginia, Div. Mineral Resources, Bull. 75, 86 p., 6 figs., pl., 11 tables, 1960, 20 refs.

Ground water in Pittsylvania and Halifax counties is utilized by about two-thirds of the population. It is used in all rural areas, some industrial areas, and the town of Halifax. Surface water is used by the municipalities of Chatham, Danville, Gretna, and South Boston.

These counties are located in the S.-central part of Virginia and are in the Piedmont province. Topography within these counties consists of low, rounded hills with gentle slopes and a few isolated ridges. Three rivers in the counties, the Roanoke River to the N., the Bannister River in the middle, and the Dan River to the S., flow eastward in channels that were cut more than 100 ft. below the upland area. These rivers receive drainage from a close network of tributary streams. Parts of all streams flow directly on bedrock, and other parts flow over a few feet thickness of channel sand. Flood-plain deposits that contain an upper zone of clay and a lower zone of sand and gravel, occur as bordering parts of all streams. Bedrock is exposed on many steep slopes

acent to valley floors. A residuum that is comsed of surface soil and as much as 60 ft. of soft athered rock covers much of the upland area. The geology of the counties is described, and the uctural and topographic characteristics of the drock are shown to be important factors that vern the yield of individual wells. The water le generally occurs in soft weathered rock, a few t above the hard fresh rock, much of which is ctured. Small amounts of water are obtained m dug and bored wells in soft weathered rock. equate domestic supplies are obtained in most es from drilled wells in fractured hard fresh k. Drilled wells range in yield from less than allon per minute to more than 100 gallons per nute; they range in depth from about 60 to 500 ft. The amount of water available from a particular ll is correlated with the surrounding topography. e average yield of wells located in draws is veral times that of wells on hills and more than t of wells in other topographic locations. More n 90% of the wells are drilled in hilly, upland as where conditions are unfavorable for large plies of water.

The withdrawal of water from wells is only a ction of that available for recharging the underund reservoir. Recharge, derived from about in. of rainfall annually, occurs in the upland as; discharge occurs mainly in adjacent lowlands. e annual recharge and discharge are in balance, d therefore there is no increase or decrease in annual trend in the fluctuation of the water table. Good quality water is obtained from fracture nes within schists and gneisses. Water from only ew wells contains objectionable amounts of the Fe purities. Water from wells in Triassic sediments hard in many cases.--Auth.

1578. Berry, Delmar W. GEOLOGY AND OUND-WATER RESOURCES IN THE RAWLINS EA, CARBON COUNTY, WYOMING: U.S. Geol. rvey, Water-Supply Paper 1458, 74 p., 3 maps col. geol. map in pocket, scale 1:63,360), diag., graphs, table, 1960, 17 refs.

The Rawlins area in W.-central Carbon County, -central Wyoming, includes approximately 634 sq. i. of plains and valleys grading into relatively gged uplifts. The climate is characterized by low recipitation, rapid evaporation, and a wide range temperature. Railroading and ranching are the rincipal occupations in the area.

The exposed rocks in the area range in age from ecambrian through Recent. The older formations e exposed in the uplifted parts, the oldest being posed along the apex of the Rawlins uplift. The rmations dip sharply away from the anticlines d other uplifts and occur in the subsurface throughit the remainder of the area.

The Cambrian rocks (undifferentiated), Madison limestone, Tensleep sandstone, Sundance formation, Cloverly formation, Frontier formation, and Miocene and Pliocene rocks (undifferentiated) yield water to domestic and stock wells in the area. In the vicinity of the Rawlins uplift, the rocks of Cambrian age, Madison limestone, and Tensleep sandstone, yield water to a few public-supply wells. The Cloverly formation yields water to public-supply wells in the Miller Hill and Sage Creek basin area. Wells that tap the Madison limestone, Tensleep sandstone, and Cloverly formation yield water under sufficient artesian pressure to flow at the land surface. The Browns Park formation yields water to springs that supply most of the Rawlins city water and supply water for domestic and stock use.

Included on the geologic map are location of wells and test wells, depths to water below land surface, and location of springs. Depths of water range from zero in the unconsolidated deposits along the valley of Sugar Creek at the southern end of the Rawlins uplift to as much as 129 ft. below the land surface in the Tertiary sedimentary rocks along the Continental Divide in the southern part of the area.

The aquifers are recharged principally by precipitation, by percolation from streams and ponds, and by movement of ground water from adjacent areas. Water is discharged from the ground-water reservoirs by evaporation and transpiration, by seeps and springs, through wells, and by underflow out of the area.

Although most water supplies in the area are obtained from springs, some domestic, stock, and public supplies are obtained from drilled wells, many yielding water under artesian pressure, and some flowing.

Dissolved solids in the water from several geologic sources, ranging from 181 to 6,660 parts per million (p.p.m.), indicate the varied chemical quality of ground water in the Rawlins area.

Water from the Cambrian rocks, Tensleep sandstone, Cloverly formation, Frontier formation, Browns Park formation, and Miocene and Pliocene rocks is generally suitable for domestic and stock use. However, water yielded to the only well sampled in the lower part of the Frontier formation contained a high concentration of fluoride. Water from the rocks mentioned above contains less than 1,000 p.p.m. of dissolved solids but in some places may contain Fe in troublesome amounts. Water from the Madison limestone and Tensleep sandstone combined, Permian rocks, and Sundance formation contains more than 1,000 p.p.m. of dissolved solids. Water in the Sundance, Cloverly, and Frontier formations is very soft.

More ground water can be obtained in the Rawlins area than is now being used. Many springs are undeveloped, and water can be obtained from additional wells without unduly lowering ground-water levels.--Auth.

12. MINERAL DEPOSITS

e also: Geophysics 2-1486; Fuels 2-1596.

1579. Williamson, D.R., and Lorraine Burgin. URCES OF INFORMATION FOR WESTERN TATES MINERAL INDUSTRIES: Colorado School ines, Mineral Industries Bull., v. 3, no. 2, p. 1-10, arch 1960.

A reconnaissance guide to the literature and other urces of information which aid working with raw materials in the western United States. Emphasis is placed on including the most productive and complete sources of information, although these might merely be additional directories with no factual data. The following categories are included: indexes and guides to the literature; selected magazines, trade publications, and bulletins; directories; selected glossaries, handbooks, and texts; general state publications; maps; federal government agencies;

state government agencies; professional geologic societies; mining associations; sources of out of print books; books reprinted; public and government libraries; universities, colleges, and associated libraries; bibliographic centers; translations; drill core libraries.--M. Russell.

2-1580. Smellie, D.W. TECHNOLOGY - MINING EXPLORATION (ANNUAL REVIEW): Can. Mining Jour., v. 81, no. 2, p. 166-168, 2 illus., Feb. 1960, 33 refs.

Canadian exploration developments during 1959 are reviewed. The Mattagami Lake area and extensions accounted for a good proportion of exploration activities.

Mention is made and references cited in regard to developments in mining geophysics and geochemical prospecting.

The status of exploration geology is commented upon. References are cited to significant publications on the genesis of massive sulfides, on the environment of sedimentary Fe deposits, and on the origin of barren iron sulfide horizons in the Canadian Shield. --W. C. Peters.

2-1581. McKelvey, Vincent E. RELATION OF RESERVES OF THE ELEMENTS TO THEIR CRUSTAL ABUNDANCE: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 234-241, 2 diags., table, 1960, 12 refs.

The tonnage of minable reserves in short tons (R) for many elements in the United States is equal to crustal abundance in percent (A) times 10^9 to 10^{10}, and all 26 elements for which data are available have ratios in the range $R = A \times 10^6$ to 10^{11}. The linear relation that appears to prevail between reserves and abundance for all except the most abundant elements is useful in forecasting reserves in large segments of the earth's crust or over the world at large. For purposes of estimating world reserves of unexplored elements a figure of $A \times 10^{10}$ to 10^{11} probably will give the right order of magnitude.--Auth.

2-1582. Ginzburg, I.I. PRINCIPLES OF GEOCHEMICAL PROSPECTING. TECHNIQUES OF PROSPECTING FOR NON-FERROUS ORES AND RARE METALS. Translated from the original Russian by V.P. Sokoloff: 311 p., 72 figs. incl. maps, secs., diags., graphs, 28 tables, New York, Pergamon Press, 1960, approx. 300 refs.

The wide application of geochemical prospecting methods at all stages of the geologic service raises the need for developing some theoretical premises of such prospecting, as well as to the need for a summation of the bulky data accumulated empirically by geologic reconnaissance, geologic prospecting, and geophysical field parties.

The author has endeavored to throw as much light as possible on problems originating in geochemical prospecting, to evaluate the relative importance of different prospecting methods, and to give a generalized view of prospecting work in different geologic, pedologic, climatic, and orographic environments, as well as to approach a clarification and an explanation of certain regularities which could serve as the basis of a rational orientation of geochemical prospecting.--From foreword.

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2. Geochemical Tracers (Indicators), p. 12-25.
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10. Hydro-geochemical Prospecting for Metals and Characteristics of Different Water Types Associated with Ore Deposits, p. 216-229.
11. The Bio-geochemical Method of Prospecting, p. 230-242.
12. The Geobotanical Method of Prospecting, p. 243-251.
13. General Conclusions in Reference to Geochemical Survey, p. 252-266.

2-1583. Bichan, W. James. THE ORIGINS OF THE MASSIVE SULPHIDES, PART I: Can. Mining Jour., v. 81, no. 3, p. 73-78, 2 illus., March 1960.

It is suggested that massive sulfide bodies are specialized examples of igneous rocks rather than deposits from dilute hydrothermal fluids. Massive sulfide ore bodies are presented as resultants of cumulative concentration from multiple diastrophic and diagenetic cycles, the final stage being rapid crystallization from a magma.

Reference is made to massive sulfide deposits in the Rio Tinto mining field of Spain. The genesis of the Spanish deposits is ascribed to magmatic segregation and flotation concentration during which bubbles of escaping volatiles carried fluid metallic sulfides toward the margins of the magma chamber, resulting in a fluid pyritic matte which crystallized rapidly in the usual paragenetic sequence. Some of the sulfides trapped within the increasingly viscous magma are considered to form disseminated deposits. Certain ore bodies are designated as results of penetration of roof rock by fluid sulfides.

Structural and textural characteristics are cited in support of the suggested method of magmatic segregation.

The proposal and supporting observations are expanded to include massive sulfide bodies at Tilt Cove, Newfoundland; Noranda, Quebec; Buchans, Newfoundland; and Bathurst, New Brunswick.-- W. C. Peters.

2-1584. Swayne, William H., and Frank Trask. GEOLOGY OF EL SALVADOR: Mining Engineering, v. 12, no. 4, p. 344-348, 2 illus., map, sec., Apr. 1960.

El Salvador is a porphyry Cu deposit on the trend of the Great Copper Belt of the Chilean Andes in Atacama province. The area's oldest rocks are Cretaceous andesitic bedded volcanics. These have been folded, faulted, and intruded by Tertiary rhyolites. El Salvador is the southernmost and largest of several centers of better-grade Cu mineralization occurring in a mineralizing belt 3 mi. long and a mile wide. Primary sulfide mineralization, in which chalcopyrite is the principal ore, was followed by secondary enrichment resulting in the formation of a chalcocite ore blanket covering an area 1,700 by 4,000 ft. and up to 950 ft. thick. It is under a leached cap of from 180 to 1,500 ft. thickness.--M. Russell.

1585. Mills, Joseph W. GEOLOGIC SETTING OF THE NICKEL OCCURRENCES ON JUMBO MOUNTAIN, WASHINGTON: Mining Engineering, v. 12, no. 3, p. 272-274, illus., map, March 1960, 3 f.

Discovery of Ni on Jumbo Mountain, Snohomish County, focused attention on the area in 1956. The paper covers the geology of the area, touching upon the following structures: sedimentary rocks, ultrabasic and basic igneous rocks, gabbro, acidic igneous intrusives, and faults. The geology of the Ni deposits is discussed.--Auth.

1586. Govorov, I. N. FEATURES OF THE MINERALOGY AND GENESIS OF THE TIN-BERYLLIUM-FLUORITE DEPOSITS OF THE FAR EAST: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, no. 58, p. 47-55, table, pub. 1959, 12 refs.

The features of a Sn-Be-fluorite mineralization are discussed. The deposits are significantly different from the deposits of Sn, Be, and fluorite described in the literature. Mica-fluorite ores and topaz greisens occur at the contacts of granites with ore bodies, and, therefore, the mica-fluorite rocks are unusual desilicated greisens formed from the replacement of limestones by fluorine solutions poor in silica.--Auth.

1587. Lukin, L.I., and E.P. Sonyushkin. STRUCTURES OF HYDROTHERMAL URANIUM DEPOSITS AND SOME PROBLEMS OF THEIR STUDY: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, no. 58, no. 3, p. 1-11, 12 figs. incl. secs., diags., pub. 1959.

In this article there are discussed the problems of the relation between hydrothermal U deposits and ore bodies as related to tectonic structures. The main structural types of the deposits are briefly characterized. The part played by the folded and faulted dislocations in the localization of U minerals is outlined.--Auth.

1588. Swanson, Vernon E. OIL YIELD AND URANIUM CONTENT OF BLACK SHALES: U.S. Geol. Survey, Prof. Paper 356-A, 44 p., 3 maps, 2 sec., 27 diags., 2 graphs, table, 1960, 83 refs.

Some black shales contain as much as 100 times more U than other common sedimentary rocks, and they also contain organic matter that will yield oil when subjected to destructive distillation. Such shales may be referred to as uraniferous oil shales and have been considered as a potential source of both oil and U; oil yield and U determinations on more than 500 samples of these shales are recorded in this report.

Slightly more than half of these samples are from the Late Devonian Chattanooga shale and its partial correlatives in the eastern and midcontinent areas of the United States. In central Tennessee, the upper member of the Chattanooga shale is about 15 ft. thick, contains 0.006% U, and will yield about 10 gallons of oil per ton of shale. Limited data indicate that the Chattanooga shale in Alabama and southern Kentucky, the Antrim shale of Michigan, the New Albany shale of Indiana and northwestern Kentucky and its stratigraphic equivalent in southern Illinois, and the Chattanooga and Woodford shales of the midcontinent area have slightly lesser quantities of both oil and U. A channel sample of 5 ft. of the Doublehorn shale member of the Houy formation in central Texas indicates that this unit has a U content of 0.009% and an oil yield of 21.8 gallons of oil per ton of shale.

Some of the marine black shales in the cyclothems of Pennsylvanian age in Illinois, Kansas, and Oklahoma contain between 0.004 and 0.010% U and yield 8 to 15 gallons of oil per ton of shale, but generally these shales are less than 3 ft. thick. Some shale units in the Phosphoria formation of Permian age in southwestern Montana, which are about 10 ft. thick, will yield 10 to 15 gallons of oil per ton of shale, but their U content of 0.002 to 0.004% is relatively low.

The few data available indicate the Sharon Springs member of the Pierre shale of Late Cretaceous age in the Great Plains area has an oil yield of less than 8 gallons per ton of shale and a U content of about 0.003%. The Green River formation of Eocene age in Colorado and Utah has beds of oil shale tens of feet thick that will yield more than 25 gallons of oil per ton of shale, but the U content of these beds is low, generally between 0.0003 and 0.0010%.

Both oil and U have been recovered in large quantities from the Upper Cambrian black shales of Sweden, which yield about 14 gallons of oil per ton of shale and about 0.023% U. Some other oil shales from foreign sources that yield 50 or more gallons per ton generally contain about 0.0005% or less U.

A fair positive relation between oil yield and U content exists for some of these shales, particularly for parts of the Chattanooga shale locally and the Antrim shale, but in other shales little or no relation is apparent. In some of the Pennsylvanian shales and in those in the Phosphoria formation the U is more closely related to the phosphate content.

Whereas the oil from these shales is inherent to and derived directly from the organic matter, most of the U is attached to or precipitated in the presence of organic matter just before or during the time of deposition of the organic-rich sediment. It is suggested that 2 types of organic matter should be distinguished, the sapropelic type derived principally from algae, pollen and spores, resins, and the fatty tissues of animals, and the humic type which is derived principally from cellulose and lignin or the woody parts of plants. The sapropelic type of organic matter generally yields 4 or 5 times more oil than the humic type, but, because of its general resistance to decay, is probably insignificant in the process of concentrating U. The humic type of organic matter, either in its solid form or as soluble humic acid extracts, or, indirectly, as it creates a reducing and acidic environment during its decay, is believed responsible for the precipitation or sorption of the U in black shales. Only where the proportion of sapropelic to humic type of organic matter remains the same in an otherwise homogeneous black shale will the oil yield and U content have a high positive correlation.--Auth.

2-1589. Dzhedzalov, A.T. THE PATTERN OF DISTRIBUTION OF IRON ORE DEPOSITS IN THE SAKSAGANIAN REGION OF KRIVOY ROG: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 53-72, 8 figs. incl. map, plans, table, pub. 1959, 7 refs.

The conditions of formation of the ancient weathered zone in the Saksaganian belt of Krivoy Rog are elucidated. A basis has been found for correlating the rich ore beds with fracture zones. The general pattern of weathering of the ferruginous quartzite and pattern of ore formation are examined.--Auth.

2-1590. Shabynin, L.I. ON THE GENESIS OF IRON ORE DEPOSITS IN SOUTH YAKUTIA: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 1, p. 32-46, 5 illus., sec., pub. 1959, 32 refs.

The main features of the geological structure and composition of the rocks and ores of the southern Yakutian Fe ore deposits, including complex B-Fe ores, are described. Existing opinions on conditions of formation of these deposits are critically examined. The arguments of the adherents of a sedimentary-metamorphic origin of Fe concentration are refuted, and the ores are shown to be skarns.--Auth.

2-1591. Laurence, Robert A. GEOLOGIC PROBLEMS IN THE SWEETWATER BARITE DISTRICT, TENNESSEE: Am. Jour. Sci., v. 258-A (Bradley Volume), p. 170-179, sec., 2 tables, 1960, 36 refs.

Residual barite deposits, derived from vein and breccia fillings in carbonate rocks of Ordovician age have been mined extensively in 3 parallel strike belts near Sweetwater, Tennessee. Geologic problems germane to the further exploitation of this mineral resource include the origin and age of the primary deposits and the breccias which contain them; relation of the barite deposits to Zn deposits of E. Tennessee; weathering of the carbonate rocks, including accumulation of the residual mantle; solution, transportation, and deposition of barite, fluorite, and silica; and the extent of ancient terrace deposits. The district presents a promising field for coordinated research in economic geology, geochemistry, geophysics, and geomorphology.--Auth.

2-1592. Castellani, Farrell. UNDERGROUND MINING FOR CEMENT ROCK: Explosives Engineer, v. 38, no. 1, p. 21-24, 6 illus., Jan.-Feb. 1960.

The Missouri Portland Cement Company's new cement plant is in the Kansas City area at the confluence of the Kansas and Missouri rivers. First operated in 1906 as an open pit production, it changed to underground mining in 1910. The present plant is a several million dollar - 2-kiln operation.

The rock mined is 36 ft. thick. The top 10 ft. is the bottom of the Winterset formation [Pennsylvanian]; the middle is a shale and "peanut rock," the Galesburg shale [Pennsylvanian]; and the bottom is Bethany Falls limestone [Pennsylvanian]. The best grades of portland cement require Fe, alumina, and silica in addition to pure limestone. These are found in the argillaceous beds. The operation at this property is unique in that this 36-ft. thickness of material can be blended into a chemically correct and balanced material for making cement. Mining methods are described.--J. W. Skehan.

2-1593. Gooch, Edwin O., Robert S. Wood, and William T. Parrott. SOURCES OF AGGREGATE USED IN VIRGINIA HIGHWAY CONSTRUCTION: Virginia, Div. Mineral Resources, Mineral Resources Rept. 1, 65 p., 19 pls. incl. map, 1960, 15 refs.

Materials used for highway aggregate in Virginia range from highly metamorphosed rocks of Precambrian age to unconsolidated sand and gravel deposits of Recent age. Limestone, dolomite, and quartzite are produced in the Ridge and Valley province. Granite, various types of gneiss, diabase, basalt, marble, limestone, sandstone, and conglomerate are produced in the Blue Ridge and Piedmont provinces. Sand and gravel are produced in the Coastal Plain province.

Aggregate is classified into grades A, B, and C on the basis of 3 physical properties: abrasion loss, specific gravity, and absorption. Tests used in determining the physical properties are described in the text and the specifications for each grade are listed.

The name and location of each aggregate producer is given in the text and on the accompanying map. The geology of each pit and quarry is described, physical test data on the aggregate are listed with each description, and the size of the operation or rate of production during 1957 or 1958 is given.--Auth.

2-1594. Grandone, Peter, and William E. Ham. THE MINERAL INDUSTRIES OF OKLAHOMA IN 1959: Oklahoma Geology Notes, v. 20, no. 3, p. 46-49, table, March 1960.

Total value of 1959 mineral production in Oklahoma is estimated at $742 million, 2.6% less than the 1958 value and 8.3% less than the 1957 record value of $809 million. Mineral fuels accounted for nearly 95% of the 1959 value, nonmetals for 5%, and metals less than 1%. Ten of the 17 minerals produced showed a gain in 1959 value over that of 1958. Helium was produced in the State during 1959 for the first time.

The major commodity is petroleum, of which 197 million barrels was produced. For the fourteenth consecutive year Oklahoma was the fourth largest producer of petroleum in the United States.--W. E. Ham.

2-1595. Pistsov, Yu. P. ON THE AGE OF THE NERTCHINSK-ZAVOD GROUP OF POLYMETALLIC ORE-DEPOSITS, EAST TRANS-BAIKAL REGION: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 3, p. 100-101, pub. 1959.

The polymetallic ore deposits of the Nertchinsk-Zavod group are post-Jurassic to pre-Lower Cretaceous.--M. Russell.

13. FUELS

See also: Geologic Maps 2-1346; Stratigraphy 2-1397, 2-1403, 2-1406, 2-1409; Geophysics 2-1487, 2-1488, 2-1502, 2-1503, 2-1504; Mineral Deposits 2-1588, 2-1594; Engineering Geology 2-1612.

2-1596. Anderson, James A., 3d. PERCENTAGE DEPLETION ALLOWANCE (In: McGrain, Preston, and Thomas J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Third Annual Meeting, June 5, 1959: Kentucky Geol. Survey, Ser. 10, Spec. Pub. 2, p. 40-47, 1959).

The concept of percentage depletion evolved over an extended period of time as the unique answer to a unique problem. That problem was to determine how mineral producers should compute a deduction from gross income which would fairly reflect the gradual exhaustion of their underground capital assets. The Congress recognized as early as 1918

at the conventional method of depreciating physical sets - on the basis of their cost - was inappropri-e, since mineral reserves could not be made or rchased at standard costs but had to be discovered. erefore, legislation was enacted which based the pletion allowance on the value of the mineral in ace at the time of discovery. This idea had oretical merit but "discoveries" had to be ad-dged and "values" had to be estimated, with the sult that depletion rates, as between producers of same mineral, varied for unpredictable and im-ecise reasons. It was decided, therefore, that idea behind discovery depletion should be trans-ed into more practical terms and that the deple-n allowance should be computed as a fixed per-ntage of the price received for the mineral at the ne or well.

The law which provides for the computation of pletion by this method is now available to the oducers of virtually all minerals - from anortho-e to Zn. Thus, the oil and gas industry has not en singled out for favoritism. Nor is the rate oil and gas inordinately high. If a barrel of oil lls for $3.00, the depletion deduction computed 27 1/2% of that price is $.82 1/2%. Certainly s amount will not normally exceed the in-place ue of that barrel - of the unit of capital being d.--Auth.

1597. Hoffmeister, William S. PALYNOLOGY S IMPORTANT ROLE IN OIL EXPLORATION: rld Oil, v. 150, no. 5, p. 101-104, port., chart, iags., Apr. 1960.

Age determinations, correlations, and guidance a favorable environment are now possible through study of microfossils which include 7 groups. ese groups as a whole cover geologic time from cambrian to Recent and in all types of environ-nt, thus providing very desirable information. The e of microforams, spores, and pollen, is supple-nted with the hystrichospherids and planktonic, tinous, and coccolith bodies. In correlation uses, earance of the same forms, diagnostic first oc-rences, or relative percentages is very helpful. res and pollen (Cambrian to Recent) abundance erally decreases away from shore, while the trichospherids (Precambrian to Recent) generally icate brackish water, and microforams (Jurassic Recent) are mostly of marine environment. The yet little used microfossil dinoflagellates (plank-(ic) are found world-wide, and the chitinozoans e particularly helpful in Paleozoic rocks which are erwise poor in microfossils. Extraction tech-ques use centrifuge of material after treatment h hydofluoric acid, solium hypochlorite, and am-nium hydroxide plus heavy liquid separation. e studies began with spores in England in 1833. ce 1938 there has been rapidly increasing use, ticularly in Sweden and Russia, with much applica-n to oil exploration in recent years in the United tes.--K. M. Willson.

1598. Pirson, Sylvain J. HOW TO MAKE OCHEMICAL EXPLORATION SUCCEED: World l, v. 150, no. 5, p. 93-96, port., diag., Apr. 60, 26 refs.

The main concept of geochemical exploration is at hydrocarbon gases diffuse to the surface of the rth through fissures, fractures, and faults. Leak-e patterns may be related or unrelated to struc-al deformations. Amounts of gas dissolved in ters increase with depth, but the waters are gen-erally undersaturated. A new concept indicates that anomalies represent leakage which took place at the time the petroleum accumulation was being formed. Formation water moving around petroleum accumulations leaves an erratic zonal distribution of minerals as shown by radioactivity, mineral alteration products, and variation in the dielectric constants. Combination of various geochemical data with diverse geoscience information is necessary for correct solutions of expectedly erratic peak and halo patterns.--K. M. Willson.

2-1599. Brake, J. A. UNDERGROUND STORAGE OF LIQUEFIED PETROLEUM GAS (In: McGrain, Preston, and Thomas J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Third Annual Meeting, June 5, 1959: Kentucky Geol. Survey, Ser. 10, Spec. Pub. 2, p. 7-12, 1959).

The fluctuating demand for its products requires that the hydrocarbon industry provide bulk storage for large quantities of liquid materials. A study conducted by Columbia Hydrocarbon Corporation showed that underground storage in caverns is the most economical type of bulk storage for liquefied petroleum gas and that the inconveniences associated with it are relatively insignificant.

This paper presents a step-by-step account of problems involved in locating a site for, constructing, and final testing of an underground cavern for bulk storage of liquefied petroleum gas.--Auth.

2-1600. Jordan, Louise. WOODWARD COUNTY'S GAS FIELDS: Oklahoma Geology Notes, v. 20, no. 4, p. 83-89, 3 maps, 2 tables, Apr. 1960, 2 refs.

Natural gas in commercial quantity was discovered in 1956 in Woodward County, northwestern Oklahoma. At the end of 1959, a total of 67 tests has been made since 1930 in the county area and of these 23, or 34% of the total, are productive of gas (one of oil). Of the 8 gas-condensate productive areas, 3 new fields were found in 1959. Production is from Missourian sandstones (Mussellem or Cottage Grove and Tonkawa) and Morrowan sandstones of Pennsylvanian age and from limestones of Mississippian age. Although shows of hydrocarbons have been noted in older rocks (Hunton, Viola, and Simpson) in some of the few (7) wells penetrating Middle Ordovician, no commercial production has been developed.--Auth.

2-1601. Roberts, Carl H. ORISKANY FOUND IN PENNSYLVANIA SYNCLINE: Oil & Gas Jour. v. 58, no. 16, p. 174, 178, map, Apr. 18, 1960.

A thick accumulation of Oriskany [Devonian] sand has been found in a synclinal position between 2 anticlines which have at best a thin impermeable veneer of this formation on their crests. Commercial gas production has been developed from this synclinal accumulation.--N. Street.

2-1602. TODAY'S ACTIVE OIL FRONTS: Oil & Gas Jour. v. 58, no. 17, p. 148-199, 2 illus., 11 maps, 3 secs., 10 logs, tables, Apr. 25, 1960.

A review of the world's most active and successful areas. It includes the following: Panhandle-Hugoton region covering Oklahoma and Texas panhandles, SW. Kansas, SE. Colorado, and NE. New Mexico; Trenton-Ordovician in Michigan; Oriskany-Devonian and lower rocks in West Virginia; Ohio; Pennsylvania; Kansas-Nebraska; the Lower Cretaceous-Edwards

in S. and SW. Texas and gas in deeper Wilcox in S. Texas; Mississippi (Cretaceous and beyond); the Green River basin, Wyoming; Alaska. In Canada the activity in the Swan Hills region in Alberta (the most active area on the continent) is reviewed, together with that in British Columbia, and in the Northwest Territories and Yukon. In France, the activity is in the Paris and Aquitaine basins.

The tables show producing formations, drilling details, etc. The text maps show the locations of the various areas of interest; sample electric logs are included for many of the areas.--N. Street.

2-1603. Ray, Edward O. RESUME OF DRILLING ACTIVITIES IN EASTERN KENTUCKY IN 1958 (In: McGrain, Preston, and Thomas J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Third Annual Meeting, June 5, 1959: Kentucky Geol. Survey, Ser. 10, Spec. Pub. 2, p. 48-50, 1959).

During 1958, a total of 439 wells were drilled in the eastern Kentucky field: 185 gas wells, 140 oil wells, and 114 dry holes. Oil production increased due to intensified drilling activity in Breathitt County; however, a slight decline in gas production was experienced. Eastern Kentucky produced 3,671,854 barrels of oil and 67,886,867 MCF of gas during 1958. The deepest test during the year was United Fuel Gas Company's S. W. Williams no. 8613T, in Breathitt County, which was abandoned in the basement complex at a total depth of 11,130 ft.--Auth.

2-1604. Kentucky Geological Survey, comp. OIL PRODUCTION IN KENTUCKY FOR YEAR 1958 (In: McGrain, Preston, and Thomas J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Third Annual Meeting, June 5, 1959: Kentucky Geol. Survey, Ser. 10, Spec. Pub. 2, p. 82, 1959).

An alphabetical listing of counties with the number of barrels of oil produced in each in 1958.

2-1605. Lytle, William S. HISTORY, PRESENT STATUS AND FUTURE POSSIBILITIES OF SECONDARY RECOVERY OPERATIONS IN PENNSYLVANIA: Pennsylvania Geol. Survey, Bull. M-41, [15 p.], 3 maps, chart, 3 graphs, 1960, 33 refs.; reprinted from: Interstate Oil Compact Commission Committee, Bull., v. 1, no. 2, p. 28-42, Dec. 1959.

Pennsylvania has had many firsts in the history of crude oil production. This state led the nation in the volume of crude oil produced from the discovery of the Drake Well in 1859 to 1895, and, though the quantity of production in the state has diminished since then, Pennsylvania still produces a preferred lubricating oil used throughout the world.

Vacuum was used in Pennsylvania as early as 1869 to increase the recovery of crude oil from the oil reservoir. The use of vacuum in the state was at its height from 1918 to 1925 and this technique is still being practiced today.

In 1880, John F. Carll first called attention to the possibilities of employing water flooding to increase the recovery of oil from the oil sands. By the early 1890's, there was some intentional, but secret, water flooding in the Bradford field. Flooding developed from the early "dump" flood used at the turn of the century to the intensive "five-spot" introduced in 1924 and in use today. The Bradford region has gained recognition today as the greatest secondary recovery laboratory in the world. Many new improvements in oil recovery techniques came out of research in this region.

In 1890-1891 the first recorded attempt to obtain additional oil by the injection of gas was made in Venango County. The use of air or gas as a driving medium to increase oil production continued to increase and by the middle 1920's was widespread in the state. Production resulting from air or gas injection reached its peak in 1929. This method is used extensively today.

Many important phases of petroleum technology had their beginnings in Pennsylvania. Early experiments in determining porosity and permeability were run in the state. The first core laboratory, the first flood water laboratory, the first diamond core of an oil-bearing sand, the first cable tool core, and the first chip core, plus many others were introduced in Pennsylvania.

As of Jan. 1, 1959, Pennsylvania's oil fields had produced 1,219,070,000 barrels of crude oil of which 327,662,000 barrels were produced by water flooding and 19,496,000 barrels by air or gas drive. The proven reserves as of the same date were 120,018,000 barrels. There are thousands of acres in the Pennsylvania oil fields including the 20-mi. long Foxburg-Clarion field which have not been subjected to secondary recovery methods.--Auth.

2-1606. Agnew, Allen F. OIL TESTS IN BLACK HILLS FRINGE, SOUTH DAKOTA: South Dakota Acad. Sci., Proc., v. 38 (South Dakota, State Univ. Bull., ser. 60, no. 2), p. 60-65, 3 maps, table, 1959, pub. 1960.

In the past 50 years, 191 tests have been drilled for oil in the Black Hills area of South Dakota, and 80% of this number have been drilled in the last 15 years. Of the 175 holes for which information is available, approximately 60% tested only as deep as the Cretaceous Newcastle or Fall River sands. An additional 25% reached the Pennsylvanian Converse or Leo sands, but only 3% penetrated all the sedimentary rocks to the Precambrian basement.

The reasons for not testing deeper include 1) lack of money, 2) narrowness of objective, 3) prejudice, and 4) promotional aspects.

The oil possibilities of the Black Hills area deserve a reappraisal.--Auth.

2-1607. Yaskovich, B.V. NEW DATA ON THE OCCURRENCE OF BITUMENS IN THE CAMBRIAN ROCKS OF SOUTHERN FERGANA: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 2, p. 99-101, 2 tables, pub. 1959, 2 refs.

English translation of GeoScience Abstracts 1-534.

1608. Russell, Harold E. DRIVING THE JAYBIRD: Explosives Engineer, v. 38, no. 1, p. 7-12, illus., chart, Jan.-Feb. 1960.

Jaybird tunnel, a 14-ft.-diameter horseshoe-shaped bore, 21,300 ft. long, is a unit of the $85 million hydroelectric power development of the Upper American River Project located 75 mi. E. of Sacramento, California, just N. of Riverton on Route 50. The project will utilize run-off from an area of approximately 250 sq. mi. on the western slopes of the Sierra Nevada. The completed project will include 10 dams, 4 powerhouses, and 7 tunnels with a combined length of 82,400 ft.

Jaybird tunnel will have a grade of 0.0025 with the tire being driven through the Calaveras formation. The Calaveras consists of folded schists, phyllites, slates, quartzites, and hornfels. Andesitic agglomerate mudflow-type material in tuffaceous matrix overlies the metamorphics along part of the alignment.

Drilling procedure, blasting technique, and the mucking operation are described in detail. The rock breaks well under the procedure used, and a minimum of secondary blasting is required. In sound rock requiring no steel support, progress has averaged 42 to 48 ft. per day per heading, requiring 4 to 5 shots each shift.--J. W. Skehan.

1609. California, Dept. of Water Resources. INVESTIGATION OF ALTERNATIVE AQUEDUCT SYSTEMS TO SERVE SOUTHERN CALIFORNIA. APPENDIX C. PROCEDURE FOR ESTIMATING COSTS OF TUNNEL CONSTRUCTION, prepared by John W. Marlette, Ernest M. Weber, and others: Sacramento: Bull. 78 (Appendix C), 74 p., 10 illus., 19 fold. plates, incl. map, secs., graphs, 11 tables, Sept. 1959, 3 refs.

During the period 1956-1959, the California Dept. of Water Resources, in connection with the Feather River and Delta Diversion Projects, carried out an investigation of alternative aqueduct systems. Results were published in Bulletin no. 78. A large number of aqueduct routes leading from the San Joaquin Valley into southern California were considered. Because of the nature of the terrain, all economical possibilities for such routes would require substantial tunnel construction, for which cost estimates were needed.--From introd.

This report, published as Appendix C. of Bulletin No. 78, sets forth a rapid, standardized method of estimating tunnel construction costs, utilizing readily available geologic data, to assist geologists and engineers in determination of feasible routes. Data for this method was obtained through review of construction case histories of 100 modern tunnel projects, inspection of tunnels under construction, and interviews with contractors. Curves are presented relating estimated rates of heading advance, for varying diameter tunnels, tunnel excavation costs, and timber lagging for 8 possible physical rock conditions. Rock conditions depicted include: intact rock; stratified or schistose rock; massive, moderately jointed rock; moderately blocky and seamy rock; very blocky and seamy rock; completely crushed or unconsolidated rock; wet competent rock; and wet crushed or unconsolidated rock.

Method involves preparation of a geologic section based on geologic mapping, geophysical surveys and drilling, or driving exploration tunnels or shafts. Rock units along tunnel alignment are classified as to expected physical condition, and estimates are prepared for rock density, estimated rock load, rib spacing and maximum depth of cover. Rates of heading advance, tunnel excavation costs, and timber lagging requirements are obtained from the appropriate cost curve for each physical rock type appearing on the geologic section.-- R. C. Richter.

2-1610. Poland, George F. ANCHORING A TUNNEL IN SAND: Civil Engineering, v. 30, no. 3, p. 59-61, 2 illus., 2 diags., March 1960.

Thorington Construction Company encountered the problem of anchoring the bottom of a vehicular traffic tunnel being constructed under the New River in Fort Lauderdale, Florida. Water level in the area is about 2 ft. below ground surface. The geologic materials are alternating layers of sand and porous limestone. The tunnel bottom (which is a 4 ft. thick tremie seal) had to be anchored because its weight was less than the hydrostatic force below it. The original plan was to anchor the tremie seal with reinforcing bars grouted in the underlying rock. This plan was abandoned because 42% of test bars pulled out of the rock.

It is known that a friction pile distributes its load in the form of a bulb. It was reasoned that the form of the "negative" load of a tension pile would be similar, but with the forces in opposite directions. Using the principle of overlapping pressure bulbs, a volume of material was trapped by anchor piles sufficient to overcome the hydrostatic force. The spacing of the piles was such that the weight of material did not exceed the design load of the piles. The piles were set by 1) driving a casing with an expandable cap to the plane of anchorage, 2) filling the casing with grout, 3) setting a number 11 reinforcing bar in the grout, 4) withdrawing the casing, and 5) fastening the bar to the tremie seal.

The novel system was proved successful when the construction cofferdam was dewatered and the tremie seal remained in place.--R. E. Pendergast, Jr.

2-1611. Abel, John F., Jr. PERMAFROST TUNNEL: Mines Mag., v. 50, no. 3, p. 12-17, 5 illus., map, 3 diags., 4 tables, March 1960, 5 refs.

A report on permafrost mining techniques, made under the direction and control of U. S. Army, Snow, Ice, and Permafrost Research Establishment, at Camp Tuto, Greenland. An experimental tunnel 300 ft. long, 10 ft. wide, and 9 ft. high was driven into a hillside of glacial till. Basic hard rock mining methods were used in portal, tunnel, and room excavation. The operation included drilling blast holes, loading, blasting, ventilating, mucking out, extending the rail, and placing protective arches. The portal required support to prevent caving of thawed and unconsolidated material, but none was required in the tunnel. The volume of material removed was 1,080 cu. yd.; 334 cu. yd. from the portal, 666 cu. yd. from the tunnel, and 80 cu. yd. from an experimental room (20 x 25 ft.) in the tunnel.

The portal required protection from rock falling from a 2-ft. active layer of unconsolidated material and material thawing out of the roof. Protective steel arches were used with lagging in the first 78 ft. of tunnel. The slot blasted into the hillside before tunneling was accomplished was 15 ft. high at the face.

The permafrost material is described as a poorly graded gravel under the unified soil classification system of the Corps of Engineers. "The till would be considered free draining and non-frost susceptible if thawed, in that no volume change would occur."

Normally no lensing would be likely to occur in the material. Ninety-five percent by weight of the material was a granite gneiss. Random fragments of hematite, epidote, olivine, and a competent silicified pink sandstone were present. The temperature in the tunnel wall ranged from -6.0°C. to -10.8°C. - in the same range as in an ice tunnel on the ice cap.

Two types of tunnel blasting rounds were used, a burn cut and a V-cut round. The holes were all drilled with 1-5/8 in. bits. Four types of explosives were used during blasting experimentation. Costs and the experimental blasting record are given. The drill round giving the best results was a 5-hole burn cut, with a total of 35 holes, using 50% nitroglycerine dynamite. Drilling rate records for the various bits and equipment are given. Bit life was 212 ft./bit. The average drill round used 36 blast holes, and drill bit and steel cost $2.12/ft. of tunnel advance.

The report concludes that excavation of frozen glacial till is feasible by conventional methods, modified to allow for the temperatures. It recommends commercial percussion drilling of blast holes with anti-freeze drill fluid. Diamond drilling is recommended for clean wall holes in the frozen till. High detonation velocity explosives are recommended for proper fragmentation.--J. R. Hyland.

2-1612. Taylor, Lloyd C. NEW DEVELOPMENTS IN WELL STIMULATION TECHNIQUES (In: McGrain, Preston, and Thomas J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Third Annual Meeting, June 5, 1959: Kentucky Geol. Survey, Ser. 10, Spec. Pub. 2, p. 28-39, 10 diags., 1959).

Hydraulic fracturing is the most important well stimulation technique developed during the past 10 years. As the result of careful study of thousands of fracturing treatments already accomplished, much engineering information, useful in planning future fracturing jobs, is now available. From study of these data, it is believed that fracture planes and area of reservoir rock exposed to fracture pattern can be determined, proper choice of propping agents can be made, and reservoir penetration can be calculated, all of which will lead to more efficient and beneficial well stimulation.--Auth.

2-1613. Symposium on Geology as Applied to Highway Engineering, 10th, Atlanta, Georgia, 1959. PROCEEDINGS: 83 p., illus., 2 maps, secs., Atlanta, Georgia Institute of Technology, 1959, refs.

This meeting, held at the Georgia Institute of Technology on Feb. 20, 1959, was the tenth assembly of these symposia which had their start in Richmond, Virginia, in 1950. The 1959 symposium was under the joint sponsorship of the Georgia State Highway Dept. and the Georgia Institute of Technology. Reports are as follows:

Felix, George D. Geology as an Aid to Right of Way, p. 1-4.

When land is acquired for highway building it is commonly necessary for geologists to render advice on the worth of mineral deposits so that just compensation is given. Other questions which have been settled with geologists' advice include claims that highway vibration and blasting operations have caused or will result in damages to property. Specific examples are cited to illustrate the problems involved.--M. Russell.

Furcron, A. S. The Distribution and Character of Stone for Aggregate in Georgia, p. 5-25.

A brief but comprehensive review of the distribution of rocks suitable for aggregate, gravel, or crushed stone. The stone industry is next to the top mining industry in Georgia. Discussion is keyed to the state geologic map of 1939. The distribution and character of aggregates is shown on a map, scale 30 in. to 1 mi., in which 11 distinct lithologic types are delineated. In 8 of these, useful stone for aggregate is available.

In the Coastal Plain of Georgia, 60% of the state, the principal source of stone will be Tertiary limestone, particularly the outcropping belt of Ocala. These limestones are not as hard as present requirements for aggregate generally demand, but with judicious planning, a very large supply of limestone can be obtained. In the crystalline and highland area, 30% of the state, foliated granites and migmatites are producing most of the commercial crushed stone. Along the southern marginal belt of the Piedmont, metavolcanic rocks are also supplying a considerable amount of aggregate. The granite rock types will remain in the future a dominant source of supply for this district. In the Paleozoic areas, all or parts of the 10 NW. counties (10% of the state), the principal rocks are the Conasauga limestone, Mississippian limestones and, to a lesser extent, Ordovician limestones.--From auth introd. and concl.

Marshall, Harry E. Design Considerations in the Treatment of Soft Foundations, p. 26-47.

The paper deals with treatment of peat and associated soft clays common to glaciated areas of the U. S. Attention is given to problems encountered in the construction of the Ohio Turnpik across the northern part of the state and the Interstate Route from Columbus to Cleveland. The materials are classified on the basis of origin as organic clays, sedimentary peat, fibrous peat, and woody peat. Methods of treatment include avoidance, total excavation, partial excavation and displacement, vertical sand drains, and bridging.--M. Russell.

Upham, Charles M. The Use of Geological Investigation in Foreign Consulting Work, p. 48-56.

Geologists are extensively called upon to provide information on the best location for roads and the materials with which to build them. Geologic studies in the Nile delta of Egypt helped locate sand, gravel, and rock for crushing, savin time and haulage. Airphoto analysis, soil resistivity surveys, and seismic surveys are partic ularly useful tools for the geologist on road-build ing projects.--M. Russell.

Seeger, Ralph W. Highway Material Survey in West Virginia, p. 57-66.

West Virginia's share of the federal Interstate Highway System is about 300 mi. Average rock quantities for base course construction will be about 31,000 cu. yds. per mi. The West Virgini Highway Aggregate Research Project is being undertaken to locate and show by means of a special map, supplies of potential aggregate in the state. Photogrammetry is used extensively. The suitability for aggregate of the most commor rocks of West Virginia is summarized on the basis of their geologic age and lithology. An observed relationship between a rock's ability to absorb liquid and percent wear by the Los Angele Abrasion Test is the basis of a quick field metho

of predicting L. A. A. T. results.--M. Russell.

Fletcher, G. A. Geology in Foundation Engineering, p. 67-73.

Civil engineers should avail themselves of geologic advice in planning foundations for heavy structures. The presence of highly surcharged and glacially overconsolidated organic deposits found during the driving of pilings in Milwaukee, Wisconsin, would have been discovered at less cost had a geologic reconnaissance been made. The presence of an extremely irregular bedrock surface under an industrial site in Childersburgh, Alabama, could similarly have been discovered by geologic survey before costly foundation revisions were necessary. Construction projects which have benefited from prior knowledge of geologic conditions include eastern Manhattan Island, New York, where it was found that overconsolidated glacial lake deposits would support friction pilings, thus eliminating the need to drive to bedrock, and Georges Bank off New England, where foundation construction for the Texas Tower was simplified by prior knowledge that the bottom consisted of glacial deposits.--M. Russell.

Belcher, Donald J. Applied Geomorphology, p. 83.

In order to refine geomorphology to the point where highway engineering requirements are served, a fourth order of 36 geomorphic units are defined, and a fifth order of micro-forms or micro-features is recognized. The role of geomorphic analysis in locating materials and indicating superior road alignments is illustrated by examples of work for the West Side Freeway, San Joaquin Valley, California; the Sumpter, South Carolina, by-pass; Virginia highway paralleling U. S. 1, S. of Washington, D. C.; the Massachusetts Turnpike, northern extension; and a Pennsylvania project. Photogrammetry is used extensively in this work.--M. Russell.

1614. Widmer, Kemble. GEOLOGICAL PROBEMS IN THE CONSTRUCTION OF DAMS: New rk Acad. Sci., Trans., v. 22, no. 4, p. 223-232, maps, secs., Feb. 1960, 3 refs.

Engineering geology is the application of all ases of geology to engineering problems. Geologic vestigation of 4 dam sites in New Jersey required e use of regional and detailed structural geology, ratigraphy, petrography, petrology, geophysics, rphoto interpretation, paleontology, ground-water ology, geomorphology, historical geology, and eistocene geology.

At an unidentified dam site, the spacing, continuy, and direction of faults and jointing in quartzite e being determined. The faults and joints are otential zones of leakage into adjacent valleys that e several hundred feet lower than the reservoir.

At the Charlotteburg reservoir, joints and buried annels are potential zones of leakage. The direcons of the joints were plotted on a Schmidt net to etermine the best angle to drill grout holes in tensely folded and faulted Precambrian gneiss. A eistocene geologist determined the direction of ice ovement in order to locate buried channels.

Geophysical surveys in Round Valley showed that diabase was a ring dike instead of a cone sheet. this site a core sample identified as limestone agged downward in a fault was reidentified petroaphically as a badly fractured gneiss rehealed by lcite.

A dam and reservoir site on Spruce Run required intensive investigation because of complicated faulting and folding. The stratigraphy was determined outside the project area, and key beds were traced into the site. Faults were determined by airphoto interpretation. Depth to sound rock was found by geophysical methods. A ground-water survey included location of the water table and examination of wells and springs. Two different ages of solution cavities were found by examination of core samples. --R. Van Horn.

2-1615. Rich, George R. THE NIAGARA PROJECT-DESIGN: Boston Soc. Civil Engineers, Jour., v. 47, no. 1, p. 1-17, Jan. 1960.

This power project, whose various phases lie within an area of 6 x 3 mi., consists of 1) a water intake 3 mi. above the Falls on the U. S. side; 2) waterways; 3) a pump-turbine generating plant with storage reservoir; 4) a conventional generating plant; 5) power transformation and transmission facilities, as well as parkway facilities.

The waterways consist of 2 horseshoe-shaped conduits of reinforced concrete 46 ft. wide and 66 ft. high, constructed by cut and cover methods in the calcareous beds of the Lockport formation. These will carry water from the intake to the forebay/afterbay of the Tuscarora pump-turbine generating plant.

The rocks at the site are well-bedded sediments dipping to the S. at 30 ft. per mi. They are jointed but not faulted. The upper beds are of the Lockport formation, containing numerous joints whose bedding planes are opened, and have been further affected by solution activity. These occur beneath thin clay, gravelly sand, and sandy silt soils which are 4 to 32 ft. thick along the waterway.

To insure against slides in the escarpment face at the Lewiston generating plant 1) excavation is made at an angle of 45°; 2) a grout curtain is provided well upstream of the intake mat and extending into the shale strata (the Rochester, Clinton, Power Glen, and Queenston shale formations), interbedded in calcareous formations; 3) a system of drains is installed to collect any possible percolation not intercepted by the grout curtain.

Maps of the various elements of the project are provided; their design and seismic loading for structures is discussed.--J. W. Skehan.

2-1616. Hall, W. M. THE NIAGARA POWER PROJECT - ADMINISTRATION AND CONSTRUCTION MANAGEMENT: Boston Soc. Civil Engineers, Jour., v. 47, no. 1, p. 18-30, Jan. 1960.

Includes a detailed account of construction problems encountered and the ways in which they were solved, particularly those arising from urban and industrial congestion. Problems of relocation of railroads and electrical transmission facilities, removal of 10 million cu. yds. of material from the side of the gorge, and construction problems presented by the steep slope on the side of the gorge are described. --J. W. Skehan.

2-1617. Praszker, Michael. DEVELOPMENT OF MARGINAL LANDS IN SAN FRANCISCO: Civil Engineering, v. 30, no. 2, p. 68-71, 5 illus., 2 diags., Feb. 1960.

Disastrous earth slides triggered by heavy rains in the hilly areas of San Francisco have forced the home building industry to use sound exploration, soil mechanics, and grading principles and procedures. In the West Twins Peak subdivision, explora-

tion revealed several bedrock ravines overlain by eolian sand and alluvial fine-grained soils containing lenses of coarse, water-bearing material. Bedrock is weathered arkosic sandstones, thin-bedded cherts, and basic intrusives. Active earth movement was discovered in a large ravine which was to receive fill to a depth of 100 ft. The bottom of the ravine was excavated, and cuts were made 5 ft. deep in bedrock to provide shear keys and shoulder drains. At the head of the ravine a slip zone of puttylike clay underlain by springs was located and subsequently excavated to form a series of parallel drainage ditches normal to the slope. In cuts that showed imminent signs of failure, water-bearing sandy layers were exposed which could have supplied water to initiate and lubricate slides. To assure rapid drainage of the slopes, holes were drilled in back of the head of the cut to the toe of the cut and filled with gravel. The final product is a terraced system which has withstood several "wet winters" and a sharp earthquake.

Exploration in topographically rugged Mira Loma Park subdivision revealed soft clay layers and rock terraces filled with alluvium. The material was removed, drains were emplaced, and the site was then filled, except where final grade was close to bedrock. In those places, concrete piers were emplaced from just above the soft layers to rock.--R. E. Pendergast, Jr.

2-1618. Kuiper, E. SEDIMENT TRANSPORT AND DELTA FORMATION: Am. Soc. Civil Engineers, Hydraulics Div., Jour., v. 86, no. HY2, pt. 1, p. 55-68, 2 maps, sec., diag., Feb. 1960.

This paper deals with sedimentation computations that were carried out in connection with dike design for the Saskatchewan Delta Reclamation Project. The first part of the paper gives a description of the regime of the Saskatchewan River in general and of the Saskatchewan delta in particular. The second part presents some observations on delta formation. The third part discusses the sedimentation problems that were encountered in the design of dikes. The fourth and final part presents the method that was adopted to determine the future rate of sedimentation on the floodplains adjacent to the projected dikes.--Auth.

2-1619. Hansen, J. A., Donald Thomas Davidson, and Chalmer J. Roy. GEOLOGIC AND ENGINEERING PROPERTIES OF TILL AND LOESS, SOUTHEAST IOWA. PROGRESS REPORT, NOVEMBER 1, 1959: 48 p., 15 figs. incl. illus., maps, graphs, 5 tables, Ames, Iowa, Iowa Engineering Experiment Station, 1959, 37 refs.

Readily available sources of crushed aggregate suitable for road construction occur within only a small portion of Iowa's total acreage. Federal and state highway construction programs will impose great demands for road and paving materials, and some suitable material must be found to substitute for the aggregate. The Iowa Engineering Experiment Station, Iowa State College, is engaged in a study of the loess and glacial till materials which have been estimated to cover 80% of the state. The field work upon which this report is based was conducted in the lower 3 tiers of counties in southeastern Iowa. The investigation is Project HR-I of the Iowa Highway Research Board, and Project 283-S of the Iowa Engineering Experiment Station.

The loess in southeastern Iowa is present as a widespread deposit which blankets the terrain. It has been removed by the process of erosion from steeply rolling landscapes and from the alluvial flood plains. Actually it is doubtful if deposits of any significance ever formed on these flood plains, as removal should have been contemporaneous with deposition.

Marked variations in clay content occur in the solum of loess-derived soils as a direct result of the differences in soil-forming factors such as slope and vegetation. The C horizons are not as highly influenced by these factors and are thus more uniform in texture, color, and clay content. C horizons studied have all been leached and are noncalcareous. Slight variations in clay content are apparent in E.-W. traverses and possibly reflect a process of eolian sorting.

Glacial till is encountered everywhere beneath the loess and is extensively exposed in rolling topography. The soil-forming factors which play an important part in the development of the loess derived solum also act similarly in till horizons. Due to the greater thickness of till deposits and to the thickness of the overlying loess, leaching has progressed downward to an average of 6 or 7 ft. Below this depth tills are highly calcareous.

The sandy silt layer which underlies the loess and which sometimes forms a part of the till solum exhibits strongly bimodal sorting characteristics. It has undoubtedly originated under conditions of slope and rill wash contemporaneous with the initial increments of loess deposition.

Studies of particle-size distribution seem to be prerequisite to any attempt at soil stabilization. Well-graded soils such as C horizon glacial till are stabilized more easily by either mechanical compaction or by the addition of stabilizing agents than, for example, the poorly graded gumbotils. High-clay soils require significantly higher amounts of stabilizing agents than well-graded sands. It can thus be readily seen that prior knowledge of particle size distribution aids in the choice of the most durable and economic method of stabilization.

Clay minerals noted in this study were montmorillonite, illite, and kaolinite. Montmorillonite has the highest cation exchange capacity of these clays, and it may be that in certain kinds of chemical stabilization this high exchange capacity would permit a greater bonding action.

X-ray analysis of the detailed study samples is an extremely useful technique for the qualitative determination of the varied mineral types. Quantitative determinations are still in the trial and error stage, but rough estimates may be made from inspection of peak intensities on the strip-chart record. No distinctive criteria for the distinction of different aged tills were observed.--From auth. introd. & summ.

1620. Southern Research Institute. THE UNSCOVERED EARTH. PROCEEDINGS OF THE NFERENCE, JUNE 11-12, 1959: 56 p., illus., rts., map, diags., graphs, tables, Birmingham, abama, 1959, refs.

The Southern Research Institute was the sponsor this conference held June 11-12, 1959, at which ecialists in several of the earth sciences gave tures designed to inform nonspecialist research d engineering executives, and businessmen, of e present status of research in their various fields. e speakers and lectures are as follows:

Martin, Thomas W. Opening Remarks, p. 8.

Kinzel, A. B. Keynote Address, p. 9-15.

English, Earl F. Harnessing Geothermal Heat, 16-18.

The results of study and experience in known fields of production and utilization of geothermal heat for steam and power.

Iselin, Columbus O'D. Problems of Marine Resurces, p. 19-21.

Report on progress being made to exploit biological and chemical resources of the oceans.

Davidson, D. M. Tapping the Earth, p. 22-24.

Report on progress being made in mining methods and exploration.

Hibbard, W. R., Jr. Tomorrow's Materials, p. -27.

The developments in metallurgy are cited to illustrate that new materials are constantly sought.

Hubbert, M. King. Energy Sources for the Next ifty Years, p. 28-31.

Predictions are made on the probable requirements for fossil fuels and nuclear energy.

Teller, Edward. Project Plowshare, p. 34-38.

Prospects for the peaceful use of atomic explosions.

Woollard, George P. The Crust and Core of the arth, p. 39-44.

Review of current theory on the crust and core and methods for investigating them.

Leggette, R. M. Water for an Expanding World, 45-48.

Discussion of the water supply problems and methods involved in solving them.

Lill, Gordon G. The Deep Hole Project, p. 49-2.

A plan to drill a hole to the Mohorovičić Discontinuity.

Nolan, Thomas B. Technology and the National inerals Problem, p. 53-55.

Discussion of the basic and applied research, development and economic climate required to insure an adequate supply of mineral raw materials.

Martin, Thomas W. Conference Summary, p. 56.

--M. Russell.

1621. Dart, Raymond A., with Dennis Craig. DVENTURES WITH THE MISSING LINK: 255 p., lus., New York, Harper & Brothers; London, Hamh Hamilton, 1959, 71 refs.

A personal and historical record from the original iscoverer of Australopithecus africanus at Taungs Bechuanaland of the circumstances surrounding that discovery in 1924 and the mixed reception it received as a result of the prevalent anthropological opinions of that era.

The author then traces the sequence of dramatic discoveries of adult, adolescent, and infantile manapes by the late Dr. Robert Broom and his assistant in the 3 Sterkfontein valley sites W. of Johannesburg and by himself and his associates at the famous Limeworks site in Makapansgat valley, central Transvaal.

Explaining the mysteries to be solved and the obstacles to be overcome, he shows how the steadily accumulating evidence during the past quarter of a century has overwhelmed opposition to the recognition of the Australopithecines, not only as the physical but also as the cultural representatives of protohumanity, and has thereby completely transformed previous concepts of the course of human emergence and the factors provocative thereof.--R. A. Dart.

2-1622. Green, Jack, and Dael Wolfle. GEA, DAUGHTER OF CHAOS: Science, v. 131, no. 3407, p. 1071, Apr. 15, 1960.

It is obvious that the science we call geology, and many of the related "geo" sciences will be applied with increasing frequency to planets, moons, and other astronomical bodies. Purists hold that the root "geo" means earth, and hence new terms must be invented to apply to each new body being investigated, for example "selenology" to apply to study of the moon. To insist on this is unnecessary and unwise; the principles of the science will be the same wherever they are practiced, or essentially so, and the name applied to the science should remain the same also. It is only necessary that the "geo" term so applied be followed by the word "of" when it is used in reference to an area other than earth. Thus for example, one should refer to "the geology of Venus."--M. Russell.

2-1623. Kartashov, I. P. CERTAIN GEOLOGIC-GEOGRAPHIC TERMS: Akad. Nauk SSSR, Bull., Geol. Ser., in translation, 1958, no. 1, p. 65-68, pub. 1959, 10 refs.

The meaning and current usage of the following terms are discussed: denudation, destruction, weathering, deluvium, erosion, washing out, deposition. It is concluded that a review and unification of the geologic-geographic nomenclature is needed.--M. Russell.

2-1624. Curtis, Neville M., Jr. PUBLISHED PAPERS ON OKLAHOMA GEOLOGY IN THE YEAR 1959: Oklahoma Geology Notes, v. 20, no. 3, p. 55-73, March 1960.

Annotated bibliography and index of 198 papers published in 1959, and concerned with the geology of Oklahoma.--Auth.

2-1625. National Advisory Committee on Research in the Geological Sciences, Ottawa. NINTH ANNUAL REPORT 1958-59 (INCLUDING SURVEY OF CURRENT RESEARCH IN THE GEOLOGICAL SCIENCES IN CANADA, 1958-59): 216 p., 6 tables, pub. 1960, refs.

The National Advisory Committee on Research in the Geological Sciences has a threefold purpose: to stimulate and coordinate geological research carried on in Canada; to suggest research projects that should receive attention; and to aid in having these

projects undertaken. Its function is to stimulate research by the universities, the federal and provincial departments of mines, and by other organizations equipped for the work.

The first part of the report gives a summary of the work of the Committee in the period Sept. 1, 1958, to Aug. 31, 1959. The second contains the reports of the subcommittees covering the different fields of the geological sciences. These record developments in 1958-1959 and suggest some further problems for study.

The report includes the annual survey of current geological research in Canada. This records information on research by the universities, federal and provincial departments of mines, research councils and foundations.--From introd.

2-1626. Muilenburg, Grace. RESEARCH AND ACTIVITIES OF STATE GEOLOGICAL SURVEY OF KANSAS, FISCAL YEAR ENDING JUNE 30, 1959: Kansas, State Geol. Survey, Misc. Rept., 40 p., 22 illus., 5 maps, diag., 8 graphs, tables, Jan. 1960, 21 refs.

The organizational plan of the Survey is outlined, and present and proposed projects of each division are discussed briefly. Topographic maps, Survey reports, and papers published elsewhere by Survey personnel are listed.--R. H. King.

2-1627. Alexandrov, Eugene A. RED CHINA STEPS UP ITS GEOLOGICAL SERVICE: Mining Engineering, v. 12, no. 3, p. 248-250, March 1960, 5 refs.

The article, based on 5 recent articles from the Soviet Union, surveys the mineral resources of China and recent stepped-up exploration activities. Administrative and educational activities in connection with mineral resources and exploration are covered.--Auth.

2-1628. MAPPING IN ANTARCTICA: Military Engineer, v. 52, no. 346, p. 144, March-Apr. 1960.

The U. S. Geological Survey's Topographic Division, with funds provided by National Science Foundation, is conducting a limited program of mapping in Antarctica. The activities are: the preparation of aerial photographic and flight specifications, and selection of areas to be flown, by a Navy squadron; establishment of positions and identification of control stations by field personnel; and the preparation of maps. Seven areas chosen for their scientific interest are: Thurston Peninsula, Sentinel Mountains, Executive Committee Mountains, Horlick Mountains, Queen Maud Range, mountains of South Victoria Land, and the mountains W. of the Ross ice shelf. Three maps of the Knox Coast at 1:500,000 are being completed on a deferred project. A map of McMurdo Sound, Ross Island, and neighboring mountains at 1:250,000 is to be prepared, as well as local areas at larger scale for geologic studies.--A. C. Mason.

2-1629. LUNAR MAPPING: Military Engineer, v. 52, no. 345, p. 62-63, Jan.-Feb. 1960.

The U. S. Army Map Service is making what is believed to be the first map of the moon by modern stereoscopic principles. Libration of the moon permits selection of pairs of photographs having angular differences up to 16°, sufficient for stereoscopic vision, although in earth mapping angular parallax of 30° to 40° is used. No method is feasible to make presently available lunar photographs taken with astronomic cameras geometrically compatible with photogrammetric stereoplotters. Currently accepted earth-mapping standards cannot be achieved; the lunar map will be at a scale of 1:5,000,000 with relief depicted by large-interval contour lines supplemented by form lines, hachures, shaded relief, scarp symbols, and spot elevations. Mapping at a scale of 1:1,000,000 is anticipated as soon as mapping methods are perfected and photographic coverage to specifications is acquired. Mapping at a scale of 1:250,000 may be possible by photographing the moon from aerial balloons. Atmospheric refraction is eliminated in photographs taken from artificial earth satellites, and maps at 1:100,000 are believed possible. The hidden part of the moon cannot be mapped until a moon-orbiting satellite is equipped to transmit suitable imagery to earth.--A. C. Mason.

2-1630. PROJECTION FOR LUNAR MAP: Military Engineer, v. 52, no. 345, p. 63, diag., Jan.-Feb. 1960.

A lunar map projection must not omit or distort polar areas and must show about 60% of the lunar surface without misleading distortion. Of presently used projections, the Lambert Azimuthal projection most nearly meets requirements, but it also produces undesirable distortion of shapes of features toward the edges. For its lunar map, the U. S. Army Map Service has modified the stereographic projection to suit the above requirements. The projection plane is tangent to the mean libration center, and rays are projected to it from a point approximately 7/26 of a diameter beyond the rear surface of the moon on a line normal to the plane of tangency. This projection reduces the scale and shape distortions to an acceptable compromise. Maximum radial displacement is 1.1, and maximum tangential scale distortion is 1.85 at the outer limits.--A. C. Mason.

2-1631. LUNAR TERRAIN STUDY: Military Engineer, v. 52, no. 346, p. 144, March-Apr. 1960.

The Military Geology Branch of the U. S. Geological Survey is making a terrain study of the surface of the moon in a joint project in which the U. S. Army Map Service is preparing a map of the moon to serve as a base for the study. The first terrain study will be at a scale of 1:5,000,000, and this is expected to be followed by a more detailed study at 1:1,000,000. An analysis of the lunar terrain is being made by photogeologists stereoscopically viewing selected libration pairs of lunar photographs. The surface of the moon will be divided into physiographic regions and subregions, and the distinguishing characteristics and principal physical features of each will be described. The study will include interpretation of the constituents, textures, and bearing power of the surface.--A. C. Mason.

2-1632. Barnard, Richard H. TERRAIN FACTORS IN AIRBORNE OPERATIONS: Military Engineer, v. 52, no. 345, p. 48-49, 3 illus., Jan.-Feb. 1960.

Sites are chosen by applying terrain intelligence to tactical needs. Maximum acceptable slopes are 2 1/2% longitudinal grade and slightly less for transverse grade for fixed-wing assault aircraft, 30% for paratroops, but 10% preferable, and 50% for helicopters, but 10% preferable. Rough ground, such as gullies, boulders, and bare rock, severely limit fixed-wing aircraft and paratroop landings, and even large-scale nonlanding helicopter operations. Soil

earing capacity is a factor for fixed-wing aircraft; varies with weather, irrigation, and drainage onditions even for the same material. Some soils, s lateritic clay, cannot sustain repeated impacts rom landing. The density of vegetation affects air- orne operations; in some cases, as paddy fields, ie associated ground conditions can be a greater bstacle than the vegetation itself. The various errain factors require mapping in advance to enable apid planning of airborne operations in emergencies. -A. C. Mason.

-1633. Whitmore, Frank C., Jr. TERRAIN NTELLIGENCE AND CURRENT MILITARY CON- EPTS: Am. Jour. Sci., v. 258-A (Bradley Vol- me), p. 375-387, 1960, 33 refs.

The development of nuclear weapons for tactical se has been followed by a concept of warfare based n small, mobile combat units equipped with heli- opters, aircraft which can land and take off on short, ketchily prepared runways, and low ground-pressure ehicles which can move across country to supply rapidly shifting force. This requires that terrain ntelligence, dealing with the effects of the ground n military construction and maneuver, be made vailable to forward units that may have to act uickly on their own initiative. Help in this effort ill come from new means of gathering information, such as radar, infrared photography, and television. se of statistical methods will accelerate terrain nalysis, especially at the strategic level. Analysis of landforms as they offer shelter from nuclear blast, and of soils which may emit neutron-induced gamma radiation, will assume an important place in terrain intelligence, as also will selection of safe routes for helicopters, tanks and supply vehicles; sites for rapid airfield construction and paratroop landings; and the suitability of soil for hasty excavation of shelters. The rapid pace of such warfare will require frequent preparation of situation maps showing areas where tree blow-down might slow troop movement or where nuclear contamination might be dangerous.--Auth.

2-1634. Baranov, V.I., and K.G. Knorre. THE SEVENTH SESSION OF THE COMMITTEE ON DETERMINATION OF THE ABSOLUTE AGE OF GEOLOGIC FORMATIONS: Geokhimiya [in translation], 1958, no. 5, p. 646-647, pub. 1959.

A brief summary of titles and subjects covered at the session, held in May 1958, at the Division of Geologic-Geographic Sciences of the Academy of Sciences, U. S. S. R. Reports included: a summary of the Precambrian geochronology of the Baltic shield by A. A. Polkanov, a report on the Precambrian history of the planet, by N. P. Semenenko, a first report on the application of the K/Ca dating method in the U. S. S. R., by N. I. Polevaya, and a communication of a new K-capture constant for K^{40} by E. K. Gerling. The use of the new constant in the Ar method leads to higher absolute ages than use of the formerly accepted constant.--F. Manheim.

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